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Dr. Charles B. Meinhold

Brookhaven National Laboratory

NOV 17 1964

Upton, NY 11973

Dear Charlie,

This package probably has a lot more in it than you would really like to know about the Bikini question, but I hope that I have furnished everything that is pertinent.

First, a bit of history for convenient reference, though I am sure that you are already aware of most of it.

After a 1967 survey of Bikini and an Ad Hoc Committee report on the radiological situation, the AEC recommended, and President Johnson approved, the resettlement of Bikini Atoll, with some restrictions upon diet and land use. Glenn Seaborg's public statement of August 12, 1968, in referring to the AEC survey report, said that it ". . . declares the Atoll once again safe for human habitation . . ." The Ad Hoc Committee Report itself contained the following statement: "No radiological precautions will be needed on Eneu because of its very low contamination level."

I shall not detail the many twists and turns of the actual resettlement of Bikini Atoll, but I'm sure you know that the new community was established not on Eneu, but on Bikini Island, where the contamination levels were 8 - 10 times higher. The result, as you know, was that when locally grown terrestrial foods

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became a significant fraction of the diet, we saw <sup>137</sup>Cs body burdens go up dramatically, and the decision was made and carried out (in August 1978) to again relocate the 139 individuals who had resettled Bikini.

From here I take you to Tab No. 1, which is a briefing paper which I prepared in June, in anticipation of a meeting with Secretary Hodel. On the cover sheet of Tab No. 1, I have modified some of the content of its second page (Other Factors No. 3) but this does not materially change the thrust of the paper.

Next, at Tab No. 2, I have provided you with the full text of Ruth Clusen's May 15, 1979, letter with its enclosure. Perhaps the only essential things to note there are:

- (1) The linkage which was established in the letter proper between the guidelines for cleanup at Enewetak and the advice regarding Eneu resettlement. In the former case, early in our understanding of the Enewetak situation--when there were indeed large uncertainties--the guides were (some would say arbitrarily) discounted by 50 percent for the annual dose and by 20 percent for the 30-year dose. I emphasize that the "discounting" had to do with planning for the cleanup. In 1979, however, Clusen strongly suggested that the discounting be applied also to the return of Bikini people to Eneu. Then, in carrying out the advice of the DOE recommendation, Under Secretary of the Interior Joseph made the following statement: "In the Department of the Interior, we strongly believe that the U.S. Government cannot use different radiation exposure criterion (sic) for the people of Bikini than that which has been set for the people of Enewetak."

Thus, conservatism in the application of the guides to planning the cleanup of Enewetak had the effect of ratcheting down the guides themselves for future application in the Marshall Islands!

- (2) Notable also in the enclosure to be Clusen letter ("Other Considerations" No. 3 on the page numbered 280) is a statement questioning the validity of "administrative controls" as a means of limiting exposure. Some would translate this into a caution: "We can't trust the natives."

At Tab No. 3, I introduce the most current dose predictions which have been developed by Bill Robison, et al, for an early resettlement. Several options are examined, including availability and nonavailability of imported foods and including a couple of cases where some time is spent on Bikini Island. In all cases, resettlement is assumed to occur in January 1981. The tables upon which I would base my comments are Nos. 24, 25, 26, and 28.

In 1980, the radiological situation at Bikini was described in a bilingual DOE publication, "The Meaning of Radiation at Bikini Atoll." I am enclosing a copy of this publication with this package and at Tab No. 4 have extracted the pertinent statements (left column of page 21). Note that in going from Robison's 130 mrem/yr (Table 24 - Imports Available) to 390 mrem, the authors chose to multiply the predicted (most probable) dose by 3 for an estimate of the highest dose for an individual. The bilingual publication is what has been given to, and briefed in meetings with, the Bikini people.

While we were contemplating the letter from Interior Secretary Clark to Secretary Hodel, Ed Lessard raised the issue of Pu body burdens in the Bikini people--an issue with which I am sure you are conversant. It led to my asking Bill Bair to convene an Ad Hoc group at Richland, which he did on August 28. Following that meeting, I think that we were all satisfied that the Pu situation is well in hand. The importance of the Richland meeting in this context is portrayed in Bill Bair's letter to me of September 12 (Tab No. 5). Here, Bill observes that the comparison of Lessard's measurements with Robison's predictions "showed excellent agreement" and that "The accumulation of data and the validation of models in recent years would seem to remove any reluctance to apply applicable U.S. limits to the Marshall Islanders."

On September 14, at a meeting in Washington, I presented a proposed draft reply (Tab No. 6) to the Secretary Clark letter (which in this package is labeled Tab A to the Draft Briefing Paper (Tab No. 1)).

Rather strong opposition to my draft came from Ed Vallario and Tom McCraw, McCraw delivering a prepared PE presentation. At the close of the meeting, I asked him to summarize his argument in writing, which he did that day and later amended slightly. The amended version listed nine numbered arguments. I have set these forth verbatim at Tab No. 7, and opposite each have provided my response.

Also at the September 14 Washington meeting, Joe Maher of PE offered to furnish PE's proposed substitute wording for the Hodel letter to Clark. On October 16, we were furnished a copy of a memo, McCraw to Tiller, with two attachments.

All of this appears at Tab No. 8 and, we are told, represents PE's current position in the matter.

With the memo you are now reading and the eight tabs I have listed, I believe that the issue for a November 27 meeting have been presented. I see them as follows:

1. The application of ICRP Publication 39. Whether or not to apply the recommendations prior to formal implementation is a policy (HQ) call. I certainly do not expect to argue that. What is really relevant to the Eneu situation, in my judgment, is the statement of Proposed New Principles for Limiting Exposures from Natural Sources of radiation. The Eneu situation is of course unique, or nearly so, in that the true natural background is as low as almost anywhere else in the world. The incremental background attributable to the acts of man is admittedly higher than that at most inhabited locales, but when added to natural background, leaves Eneu with a composite background which is unremarkable. Surely the distribution of dose commitment between external and internal is different for Eneu from the distribution elsewhere, but this distinction is not very pertinent except as it affords us opportunities for reasonable remedial measures, such as diet supplements.

Further, I think we should do a bit of interpreting in applying the distinction between existing exposure situations and future situations as these terms are used in Publication 39. A resettlement of Bikini Atoll is a future situation only because the United States removed the residents of Bikini for its own purposes and has since, under its authority as trustee, administratively denied them the opportunity to resettle. (I make no judgment here as to rightness of

these actions.) The distinction is more than semantic, for I submit that we are talking here about remedial measures rather than just planning for future situations. There is an appreciable sense of loss to the Bikini people. Their homeland and their freedoms have been withdrawn, and there is no question about the impact on their lifestyle. I believe that we must classify denial of the Bikinians' homeland as the ultimate, severe and disrupting remedial action in an existing situation, rather than as a convenient option for future planning. Having come that far, I note that the Commission has declined to recommend the adoption of a single universal action level.

2. The validity of the DOE (LLNL) dose projections. The correlation with Lessard's measured values speaks for itself. The endorsement of Bill Bair's ad hoc group (note Tab 5) seems to me to dispose of this issue in the absence of a specific and scientifically supported challenge.

3. DOE's judgment as to the effectiveness of administrative controls. Our experience is by no means extensive or uniform. I have discussed this at some length in Tab No. 1. The so-called administrative control is control of diet. This may be done in several ways, among them education, cultural modification of popular tastes and the provision of convenient sources of alternative foods. More can be done by way of education (relatively easy to achieve); we have rather drastically modified the tastes of the Bikinians (again, I make no judgment); there remains the quite feasible option of providing a convenient source of alternative foods. This is clearly within the capability of the Marshall Islands government and the people of Bikini have been provided funds wherewith they may quite well attract commercial suppliers.

Finally, I note that Secretary Clark has asked us what conditions should be imposed if the people are to resettle Eneu. My draft suggests these conditions without suggesting how they should be enforced. I claim no special expertise in adjusting cultural practices, nor do I think that the Secretary of the Interior needs to turn to DOE for advice in such matters. Ultimately, it is the people themselves who must devise ways of living in harmony with their environment.

4. The Enewetak "discount," I think I have said almost all that needs to be said on this subject. I might add, though, that the idea of reducing the standards for planning purposes at Enewetak came as a result of large uncertainties in our data and in our understanding of bioenvironmental processes, pathways to man and cultural practices. Since that time, all of these subjects have been extensively studied and are far better understood.

5. The final issue has to do with acceptance of risk. I have discussed this in Item No. 7 of Tab No. 7. The risk benefit equation is an important concept, but we must resist the temptation to weigh the Bikinians' benefits against our risks. In an attempt to protect ourselves against criticism, embarrassment, claims and lawsuits, we have looked for absolute assurance against virtually any avoidable exposure to radiation. The cost of this, borne entirely by the Bikini people, has been denial of what we westerners would call a birthright. If they are not competent to make informed judgments about risk, then we as trustees have failed tragically and the time is not at hand to terminate our trusteeship. I happen to believe that the time is at hand and that the Bikinians have not just the right, but the ability to manage their destiny if we continue with responsible actions in their behalf.

On the second page of this briefing paper, please refer to "Other Factors" No. 3. The sentence which starts "Superficially, the radiological conditions . . . , etc." is correct but can be made more precise as follows:

Superficially the radiological conditions at the residence island of Rongelap and at Eneu Island at Bikini, are similar. In fact, if one compares the two bilingual DOE publications on the subject which have been made available to the people of the two communities, the radiological situation would appear to favor Eneu. This misrepresents the true situation and clarifying action will be taken, but the fact remains that there is not a great difference between the two islands.



Draft Briefing Paper

RESETTLEMENT OF ENEU ISLAND BIKINI ATOLL  
Request of the Secretary of the Interior

Summary:

The Secretary has received a request (Tab A) from Interior Secretary William Clark for advice regarding the possible resettlement of Bikini people on Eneu Island in their home Atoll. In 1979, the DOE response to a similar request led to a decision by then Under Secretary of the Interior James Joseph to place Eneu Island "off limits as a place of residence for the Bikini people for at least another 20-25 years" (Tab B). In view of recent developments, some of which are discussed below, a prompt review and response to Secretary Clark is in order.

Background:

The people of Bikini Atoll (167 persons) were removed from their atoll by the United States in 1946 to permit Bikini lands and waters to be used for atmospheric nuclear testing. Having been relocated to areas which were remote from the testing sites, the people sustained no significant radiation exposures from the tests, but their home islands, and especially the main residence island, Bikini, were contaminated with radioactive test debris. After a cleanup and rehabilitation program and the release of the atoll from further U.S. use, a small number of Bikinians (about 140 of the current population of about 1100) resettled Bikini Island during the period 1969-1978. DOE continued to monitor the Bikini environment and the resettled Bikinians during this period. By the mid 1970's, as locally grown foods became increasingly available, and as DOE studies established the importance of the food chain as the dominant contributor to radiation dose, DOE surveillance was intensified.

Early in 1978, it became evident that under the conditions then existing at Bikini Island the resettled residents would not be expected to stay within the U.S. Federal guidelines for exposure to radiation. This led to the second relocation of Bikinians from their atoll in August 1978. Recognizing the strong desire of the Bikini people to return to their homeland, the two departments (DOE and DOI) considered in 1979 whether Eneu Island, a somewhat smaller island in Bikini Atoll, six miles distant from Bikini, might be suitable for resettlement.

On April 12, 1979, Under Secretary Joseph wrote to then Assistant Secretary of Energy Ruth Clusen and, in Secretary Joseph's words "...insisted that a definitive statement on the use of Eneu Island, Bikini Atoll, was an absolute necessity..." Secretary Clusen replied on May 15, 1979, with a lengthy and detailed analysis of the Eneu situation and, although she did not make a categorical or definitive recommendation, her letter left the Department of the Interior little choice but to take a conservative position on Eneu resettlement. The wording of Secretary Joseph's decision--"off limits...for...20-25 years"--may be viewed as somewhat stronger than was justified, but is understandable, considering the popular sensitivities and apprehensions regarding radiation matters.

The Bikini people continue in their strong desire to resettle their home atoll. Responding to their request, the 97th Congress authorized and funded (\$400K) an independent study of the feasibility of rehabilitating Bikini Atoll. The study committee was chaired by Dr. Henry Kohn, Professor Emeritus of Radiation Biology, Harvard Medical School, and issued its interim report in early 1984. The report (page 22) indicates that Eneu may be resettled now.

In Congressional testimony\* on May 1, 1984, Professor Kohn stated: "Some of the islands are safe for resettlement now. The important one of these is Eneu (1.2 km<sup>2</sup>)."  
Dr. Kohn's conclusions and those of his independent committee (The Bikini Atoll Rehabilitation Committee) are largely based upon DOE sponsored field studies and upon calculations of Lawrence Livermore National Laboratory under DP's Marshall Islands Program (managed by NV).

Assuming Congressional approval of the Compact of Free Association, which the President submitted to the Congress for approval on March 30, 1984, responsibility for decisions regarding resettlement will rest with the constitutional government of the Republic of the Marshall Islands. However, provision is made in the Compact and in a related subsidiary agreement, for the Republic to request, and the United States to provide, technical assistance in this and related matters. In addition, the United States is committed to assisting the Bikinians with resettlement of their homeland when this becomes feasible. The Secretary of the Interior, therefore, desires to again consider the acceptability of Eneu for resettlement.

#### Other Factors:

1. The People of Bikini have filed in the United States District Court for the District of Hawaii (Secretaries Hodel and Clark are among the named defendants) to compel the United States to clean up and restore Bikini Atoll. Positive and responsible actions to provide relief to the Bikini people (resettling Eneu, for example) could well influence the progress and outcome of that suit.
2. The concerned Congressional committees have exhibited a strong interest in the plight of the Bikinians, and their perceptions of the administration's actions in this matter may be expected to influence action on the President's request for Compact approval.
3. The people of another atoll, Rongelap, were resettled in their home islands in 1957, three years after their relocation. As they have recently become more aware of the circumstances of their relocation and of their resettlement, they have attempted to draw a comparison between their atoll and Bikini atoll. In spite of assurances by U.S. officials and scientists, and in part under the influence of aggressive claims lawyers, they have concluded that they are being deliberately, or at least knowingly, placed at risk. Superficially, the radiological conditions at the residence island of Rongelap and at Eneu Island at Bikini are quite similar, with the difference, in fact, favoring Eneu. Recently, the people of Rongelap have expressed fear regarding their exposure to radiation hazards, and Marshall Islands Government officials have appealed to the United States Congress to authorize and fund their immediate relocation and resettlement. Disposition of the Eneu question will undoubtedly have an impact upon the Rongelap issue.

\*House Appropriations Subcommittee on Interior and Related Agencies.

4. There is a related matter of unfinished business at Enewetak Atoll, where a major sub-group, the people of Enjebi, are not yet resettled in their home island. The Enjebi people petitioned the Secretary of the Interior in 1979 to effect their resettlement. Their attorney has sought to have a resettlement trust fund established as a part of the Compact approval. Again, the Enjebi question is similar to, and may be expected to be influenced by, U.S. actions regarding Eneu.

All of the above factors have entered into Congressional consideration of the Compact and have been the subject of recent exchanges in the Trusteeship Council of the United Nations.

#### The DOE Role:

Historically, the DOE and its predecessor organizations have provided technical advice, support, and assistance to those in authority in the Department of the Interior and the Trust Territory of the Pacific Islands. As a practical matter, DOE's field personnel, including those in the contractor laboratories, have been looked to for advice by the resident peoples and their local government authorities. DOE representatives have tried to limit their advice to matters encompassed by their special knowledge and experience, but the complex interaction of cultural, social and economic considerations makes this difficult. In the instant case there is clearly no unique mathematical solution. Even the applicability of Federal radiation guidelines is not entirely straight-forward.

Further, when one looks at pathways and sources of radiation exposure, certain assumptions must be made as to lifestyle, availability of imported foods, etc. In fact, the composition of the assumed diet can alone at least double (or halve) the predicted radiation dose. And, finally, the degree to which a potential health risk is acceptable to the people themselves is a matter beyond the ken of DOE officials or scientists. Thus, we in DOE are faced with an obligation to do our best to inform the people themselves, and those to whom they entrust the power of decision, of the likely consequences of the various alternative courses of action, leaving the decisions to those whom the decisions affect. The Department of the Interior view seems to be that implicit in the Trusteeship is the obligation to make and carry out decisions affecting the health and safety of the Micronesian peoples. But as executive agent for the Trust, the DOI must rely upon technical advice from the DOE.

Consensus within the DOE staff will not be easy, for there are honest differences of opinion regarding both the role of DOE and the issue itself. The integrity of radiological safety standards, potential legal and financial liability, the cost of continued DOE involvement in the Marshalls, the relationship between this issue and the on-continent "down-wind" problems--are but some of the ramifications. In the face of these, DOE's recent advice has in general been conservative. Such conservatism, which ultimately has its price in freedom of action and in the people's right of self determination, deserves periodic reexamination.

The Secretary of the Interior has asked the Secretary of Energy for advice in these matters, and has specifically asked to be informed of what conditions, if any, should be imposed if the people of Bikini are relocated to Eneu Island. The requisite information is available to allow the formulation of such advice. It is recommended that the Secretary direct the staff to review this information and develop realistic options which might be available to the Secretary of the Interior.

Postscript:

The DOE Marshall Islands program, responsibility for which currently rests with DP, is in need of Secretary level review and policy guidance. The matter addressed in this paper is but one facet of a DOE responsibility which is currently undergoing dramatic change.

The entire Marshall Islands program, small in dollar value but high in current visibility and political potential, is a legacy of the atmospheric nuclear test program in the Pacific (1946-1958). The committees most familiar with and most active in this Pacific area evidence their determination that the United States Government continue an active role in dealing with the environmental, medical, and radiological consequences of the test program.

On the other hand, the committees to which DP looks for authorization and appropriations have questioned continued funding for this program by DP. Taken literally, the Compact of Free Association, which is current Administration policy, would terminate DOE involvement. However, without a reasonable transition to smooth the transfer of responsibility, the likely result would be an abrupt diminution of technical services and support to the test-affected populations.

An early program review for the Secretary is recommended.



THE SECRETARY OF THE INTERIOR  
WASHINGTON

July 5, 1984

The Honorable Donald P. Hodel  
Secretary of Energy  
Washington, D.C. 20585

Dear Mr. Secretary:

The Compact of Free Association, which the President transmitted to the Congress on March 30, 1984, will provide the means of terminating the United States' trusteeship in the Marshall Islands. In the short time that remains before the termination of the Trusteeship, we are eager to learn your views on the possibilities for the resettlement of the people of Bikini in their home atoll. As you know, the resettlement of Bikini in the 1970's was aborted in August 1978 after monitoring by the Department of Energy revealed higher-than-expected body burdens of Cesium 137. The high counts were seen as resulting from the consumption of foods grown on Bikini. Eneu Island, within Bikini Atoll, was then considered as a relocation site for the community, but on the advice of the Department of Energy, the Department of the Interior decided not to permit a resettlement of Eneu in 1979.

We would like to determine whether we can permit the Bikinians to return to Eneu before the trusteeship ends. When the Congress approves the Compact of Free Association, the Republic of the Marshall Islands will have a full measure of self-government, and will be responsible for decisions regarding a return to Bikini. Recognizing our trust responsibilities, however, we would like to again consider the acceptability of Eneu for resettlement at this time and, if we cannot now support such resettlement, to provide to the Marshall Islands Government the requisite information for its future management of this issue.

The Department of Energy studied the question of relocation to Eneu and set out its findings in a letter dated May 15, 1979, from Assistant Secretary for Environment Ruth C. Clusen (copy enclosed). We would expect, however, that in the five years, some of the uncertainties which then existed might have been resolved, and that at least some improvement might have occurred both in our knowledge and in the conditions which led to earlier recommendations.

The Honorable Donald P. Model  
Page 2

It seems likely also that the Bikinians are somewhat more knowledgeable in administrative controls. We believe it is pertinent to note our experience in Rongelap Atoll where we have good evidence, confirmed by DOE's bio-assay program, that diet restrictions are being adhered to.

We would appreciate your advice in these matters and ask you to update the Department of Energy's evaluation and inform us what conditions, if any, should be imposed if the people of Bikini are relocated to Eneu Island in their home atoll.

Sincerely,

A handwritten signature in dark ink, appearing to read "Bill Clark", with a stylized flourish at the end.

William Clark

Enclosure



## United States Department of the Interior

OFFICE OF THE SECRETARY  
WASHINGTON, D.C. 20240

MAY 31 1979

Honorable Adrian P. Winkel  
High Commissioner  
Trust Territory of the  
Pacific Islands  
Saipan, Mariana Islands 96950

Dear Mr. Winkel:

On May 15, 1979, Assistant Secretary for Environment Ruth C. Clusen, replied to my letter of April 12, 1979, in which I had insisted that a definitive statement on the use of Eneu Island, Bikini Atoll, was an absolute necessity in order to enable our Department and you to meet the United States' obligation to the people of Bikini.

In the May 15, 1979, reply, the Department of Energy stated unequivocally that unless imported food is a major and continuing part of the diet of the Eneu population for at least 20 years, unless residence is restricted to Eneu, unless visitation to Bikini Island is effectively controlled, and unless access to food to Bikini Island is restricted, radiation doses to people living on Eneu Island would not be in compliance with current Federal radiation protection guidance. This would be the current Federal standard exposure limit of 500 mrem/yr to individuals. There is no way that this Department or the United States Government can ensure that the rigid stipulations of possible use of Eneu Island can be guaranteed for the next 20 years.

Crucial, however, was the reminder by the Department of Energy that when the Enewetak program was being developed, the Environmental Protection Agency recommended that the U.S. Government cut the Federal radiation criteria exposure in half for the people of Enewetak as individuals, and this was done. In short, for the people of Enewetak, the radiation criteria exposure standards were set at 250 mrem/yr to individuals. If we apply the same radiation criteria standard for the people of Bikini, then the Department of Energy advises that a return to Eneu Island cannot take place for 20-25 years even with imported food.

In the Department of the Interior we strongly believe that the U.S. Government cannot use different radiation exposure criterion for the people of Bikini than that which has been set for the people of Enewetak.

In that context, then, there is no question but that the island of Eneu must be placed off limits as a place of residence for the Bikini people for at least another 20-25 years.

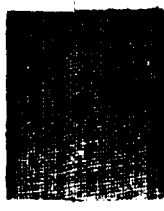
This being the case, I believe these facts must be carefully discussed with and made known to the people of Bikini by you. We must ask them to accept this decision so that with them and their counsel all of us can now turn to the very pressing problem of where permanent resettlement can be arranged for the people of Bikini.

Copies of the Department of Energy's May 15, 1979, report, Radio logical Implication for Resettlement of Eneu Island, have been provided to the Legal Counsel for the people of Bikini for his discussions also with his clients. I enclose for your information a copy of Mrs. Clusen's letter of May 15, together with its enclosure, as well as our letter of April 12.

Sincerely,

  
UNDER SECRETARY

Enclosure







Department of Energy  
Washington, D. C. 20585

May 15, 1979

Honorable James A. Joseph  
Under Secretary of the Interior  
Washington, D. C. 20240

Dear Mr. Joseph:

I am pleased to reply to your letter of April 12, 1979, regarding the possible return of the Bikini people to Eneu Island.

This response will address both of the issues you raise:

1. Your understanding of previous statements by my staff.
2. More detailed information on estimated dose assessments for people living on Eneu Island, including various assumed living and eating patterns.

With respect to the first point, your understandings are, in general, correct. The more detailed information addressing the second point is included as an enclosure to this letter.

If the guidance of the Federal Radiation Council (FRC) (500 mrem/yr to individuals, and 170 mrem/yr and 5000 mrem/30 yrs to a population) is to be complied with, the people could return to Eneu only if it is assured that adequate imported food would be available to and used by the people for approximately 20 years, that food grown on Bikini Island is not a part of the diet, that residence is restricted to Eneu Island, and that visitation to Bikini Island is effectively controlled.

Since the FRC guides were originally formulated, an Environmental Impact Statement (EIS) was prepared for the resettlement of Enewetak Atoll. In the EIS, recommended criteria which are one-half of the FRC guidance for individuals and 80 percent of the 30-year FRC guidance for populations were proposed for evaluating land use options for use in planning the cleanup and rehabilitation of Enewetak Atoll. These criteria were recommended because of uncertainties in estimating future doses to the people at Enewetak Atoll. However, following the return of people to the Islands, direct radiation exposure measurements would

be available and compared with the full FRC guidance of 500 mrem/yr to individuals and 5000 mrem/30 yrs to the population. These criteria for Enewetak were reviewed by interested Government agencies; no objections to these criteria were raised. One of the reviewing agencies, the Environmental Protection Agency (EPA), found the criteria acceptable, but considered them to be "... upper limits ..." and that "... any proposed guideline or numerical values for the dose limits are only preliminary guidance and that a cost-benefit analysis must be undertaken to determine whether the projected doses are really as low as readily achievable and practical before proceeding with the relocation project. On the basis of such analysis it may be prudent to lower dose guidelines for this operation."

The degree of uncertainty in estimating doses on Eneu Island is similar to that for Enewetak Atoll. Assuming, therefore, that Enewetak criteria are applicable to other similar situations in the northern Marshall Islands, the dose estimates for return of the Bikini people to Eneu Island would be compared to the Enewetak criteria as described above rather than to the FRC guidance. When this is done, it is found that even with imported food the radiation doses to the people on Eneu would not be expected to be in compliance with the Enewetak criteria for about 20-25 years.

Several basic combinations of residence and food constraints are discussed in the enclosed, and are illustrated and summarized in the attachments to the enclosed. Other considerations also are addressed. If any further refinement of the data changes these estimates in a significant way, we will immediately inform you.

We trust that this is helpful to you in resolving the issue of the acceptability of Eneu Island as a residence island.

Sincerely,

*Ruth C. Cluser*  
Ruth C. Cluser  
Assistant Secretary for Environment

Enclosure

cc: Dr. William Mills, EPA

RADIOLOGICAL IMPLICATION  
FOR RESETTLEMENT OF ENEU ISLAND

SUMMARY

Unless imported food is a substantial and continuing part of the diet of the Eneu population for about 20 years, unless access to Bikini Island can effectively be controlled for several years, and unless access to food from Bikini Island is restricted, it is unlikely that radiation doses to people living on Eneu Island would be in compliance with federal radiation protection guidance.<sup>1</sup> Based upon previous experience and past practices, however, it is doubtful whether imported food will be a significant part of the daily diet. It can also be questioned whether or not access to Bikini Island can be controlled. Therefore, a return to Eneu Island should be delayed for close to 20 years if radiological dose is the only governing factor unless a firm commitment can be made which will guarantee that adequate imported food will be available and used by the people, and that residence can be restricted to Eneu Island. If the Enewetak radiation exposure criteria<sup>2</sup> are to be applied to the Eneu population, it is unlikely that the radiation doses to the people would be in compliance with the criteria for approximately 20 years, even if imported food is available and if mobility is restricted. Under either criteria, a return to Bikini Island would be delayed even longer because of the higher levels of radionuclides in the soil.

<sup>1</sup>The Federal Radiation Council (FRC) recommended exposure limits of 500 mrem/yr to individuals, 170 mrem/yr to average population groups, and 5000 mrem/30 yrs to the average population of the U.S.

<sup>2</sup>Enewetak criteria are one-half of the FRC exposure limit for individuals and 80 percent of the FRC 30-year exposure limit.

BACKGROUND

In August 1978 the residents of Bikini Island left their Atoll because measurements of radiocesium made in April 1978 showed accumulations in the bodies of 13 out of 101 people such that if this level were maintained for one year, it would result in an annual radiation dose equal to or greater than the 500 mrem/yr federal radiation protection criteria for exposure of individuals. The dose rate might have increased further had those people continued to live on Bikini Island. At that time the question was raised about whether or not the Bikini people could relocate on Eneu Island. Information then available on the radionuclide content of test plantings of food crops on Eneu was inadequate, and there were insufficient samples of coconuts grown on Eneu Island to answer the question. In the Congressional Committee hearings<sup>3</sup> held on July 25, 1978, it was agreed that priority would be given to collecting and analyzing available data to update radiation exposure estimates for use by those who are considering whether the Bikini people should return to live on Eneu Island. In early 1979, new information was obtained so that dose predictions for residence on Eneu Island could, for the first time, be based upon data from analysis of actual food items of the diet grown on the island rather than on theoretical predictions derived from soil concentrations.

RADIATION SOURCES

People living on Eneu Island receive radiation exposure from two sources: 1) external irradiation from natural background radiation

<sup>3</sup>Interior and Related Agencies Subcommittee, Committee on Appropriations, House of Representatives.

(which is very low) and from radionuclides remaining in the soil from nuclear tests at Bikini Atoll; 2) internal irradiation from radionuclides deposited in the body as a consequence of eating foods from the island area (including foods grown in the contaminated soil and marine life from the lagoon) and from inhaling airborne radionuclides. Because of the metabolic characteristics of the predominant radionuclides (cesium-137 and strontium-90) at Eneu, bone marrow doses are expected to be slightly greater than whole body doses, and will be the limiting exposure.

The external radiation dose rate has been determined from data obtained during a recent aerial radiological survey. The external doses to whole body and bone marrow for Eneu residents were calculated using measurements of external radiation and estimates of time spent in various areas of the island (e.g., village, island interior, on the lagoon, etc.).

The internal radiation doses were calculated from estimates of the amounts and kinds of food in the diet (with and without imported foods) and from measurements of the radionuclide content of these foods and of drinking water (see Attachments 1, 2, 3, and 4). Levels of radioactivity in food shown in these attachments were obtained from analysis of samples collected on Eneu Island, except for pandanus which was not yet available. Since pandanus would be a diet constituent, the contributed dose is calculated from uptake coefficients and soil concentrations of radionuclides. The 30-year dose commitment is calculated assuming only radioactive decay with no reduction from other possible mechanisms.

It is expected that some individuals on Eneu Island will receive doses higher or lower than the predicted average dose. This may result from: 1) eating a larger or smaller quantity of food than that shown in the assumed diet, 2) eating more or less of certain foods containing the highest radioactivity levels, and 3) eating foods grown from areas on the island having soil concentrations higher or lower than the average. In this regard it should be noted also that the former "...Federal Radiation Council suggests the use of the arbitrary assumption that the majority of individuals do not vary from the average by a factor greater than three."<sup>4</sup> This factor of three is used in establishing and distinguishing between guidance for the maximum annual dose to the average individual within that population and guidance for the potentially highly exposed individual within that population.<sup>5</sup>

#### FEDERAL GUIDANCE

Radiation Protection Guides for the U.S. were approved by the President and are used by federal agencies in their radiation protection activities. These guides specify the radiation dose that should not

<sup>4</sup>Report No. 1, Background Material for the Development of Radiation Protection Standards, Staff Report of the Federal Radiation Council, U.S. Department of Health, Education and Welfare, May 13, 1960, pg. 27.

<sup>5</sup>The "maximum annual dose" refers to the dose in that year in which the exposure of the average individual is greatest, taking into account the buildup and the removal and decay of radionuclides in the body. The majority of the highly exposed individuals within this population are assumed not to receive an annual exposure more than a factor of three greater.

be exceeded without careful consideration of the reasons for doing so,<sup>6</sup> and that every effort should be made to encourage the maintenance of radiation doses as far below these guides as practicable. To comply with these standards, certain conditions must be met. First, the basic FRC recommendation is "...that the yearly radiation exposure to the whole body of individuals in the general population...should not exceed 0.5 rem."<sup>7</sup> The FRC recognized, however, that exposure of individuals may be difficult to monitor under some circumstances; thus they suggested that the limit to individuals may be met by the use of average limits to the population. Second, therefore, the FRC indicated that: "Under certain conditions, such as widespread radioactive contamination of the environment, the only data available may be related to average contamination or exposure levels. Under these circumstances, it is necessary to make assumptions concerning the relationship between average and maximum doses. The Federal Radiation Council suggests the use of the arbitrary assumption that the majority of individuals do not vary from the average by a factor greater than three. Thus, we recommend the use of 0.17 rem for yearly whole-body exposure of average population groups... It is critical that this guide be applied with reason and judgment. Especially, it is noted that the use of the average figure, as a substitute for evidence concerning the dose to individuals, is permissible only when

<sup>6</sup>The Federal Radiation Council, in Report No. 1 (see footnote 4, pp. 26-27), stated that the guidance should not be exceeded unless "...a careful study indicates that the probable benefits will outweigh the potential risk."

<sup>7</sup>See Note 4, p. 26.

there is a probability of appreciable homogeneity concerning the distribution of the dose within the population included in the average."<sup>8</sup> Third, "When the size of the population group under consideration is sufficiently large, consideration must be given to the contribution to the genetically significant population dose. The Federal Radiation Council... recommends the use of the Radiation Protection Guide of 5 rem in 30 years... for limiting the average genetically significant exposure of the total U.S. population. The use of 0.17 rem per capita per year, as described (above) as a technique for assuring that the basic Guide for individual whole body dose is not exceeded, is likely in the immediate future to assure that the gonadal exposure Guide is not exceeded."<sup>9</sup> Therefore, the whole body dose is considered to be the equivalent of the genetically significant dose.

Because of the absence of radiation protection guides specific for the Marshall Islands, criteria were developed from the basic Federal guidance for evaluating land use options for use in planning the cleanup and rehabilitation of Enewetak Atoll.<sup>10</sup> These criteria are presented here since they were developed subsequent to the decision regarding the cleanup and rehabilitation of Bikini Atoll. It was

<sup>8</sup>See Note 4, p. 27.

<sup>9</sup>See Note 4, p. 27.

<sup>10</sup>Cleanup, Rehabilitation, Resettlement of Enewetak Atoll - Marshall Islands, Environmental Impact Statement, Defense Nuclear Agency, April 1975.

recognized that decisions on land use involve consideration of predicted radiation doses which have inherent uncertainties. To make allowance for this, radiation criteria were chosen that are of the annual Federal guidance for individual whole body and bone marrow doses and 80% of the 30-year whole body dose for population exposures. Therefore, the Enewetak criteria limits the dose to whole body or the bone marrow of individuals to 250 mrem/yr and dose to the average individual within the population to 4000 mrem (It should be noted that use of a percentage of the FRC values was not an attempt to establish new guidance, but was considered to be a necessary precaution in the application of the FRC values. The adoption of limits for Enewetak equal to one-half the FRC guide for individuals and 80 percent of the FRC guide for 30-year limit a result "... of the uncertainty concerning dose estimates which greatly on the foods people will choose to eat and the way they choose to live."<sup>12</sup> While dose estimates are to be compared to the percentages of the FRC guides, actual exposure levels monitored the people return should be compared to the 100 percent values of FRC guides.<sup>13</sup>)

#### CALCULATED DOSES LIVING IN ENEU

The calculated doses<sup>14</sup> shown below are for three living patterns for two assumed diets. The diets are based on the recent experience

<sup>11</sup>See footnote 10, Vol. II., Sec. B, p. III-10.

<sup>12</sup>See footnote 10, Vol. I., Sec. 5, p. 5-7.

<sup>13</sup>See footnote 10, Vol. I., Sec. 5, p. 5-7 and Vol. II., Sec. B,

<sup>14</sup>All dose estimates are rounded off and are based upon information in "An Updated Radiological Dose Assessment of Eneu Island at Robison, W. L. and Phillips, W. A., UCRL-52775, 1979, in draft

and observations of the scientific teams who have been working on Bikini Atoll.<sup>15</sup>

Calculated Maximum Annual Dose (Average for Population)  
(Federal guidance is 170 mrem/yr)

- A. People live 100% of the time on Eneu Island.

	<u>With Food Imports</u>	<u>Without Food Imports</u>
Whole Body	120 mrem/yr	210 mrem/yr
Bone Marrow	140 mrem/yr	260 mrem/yr

- B. People live 90% of the time on Eneu Island and visit Bikini Island 10% of the time, or 80% of the time is spent on Eneu Island and 20% of the time is spent on Bikini Island, and assuming that no food from Bikini Island is eaten.

	<u>With Food Imports</u>		<u>Without Food Imports</u>	
	<u>90-10</u>	<u>80-20</u>	<u>90-10</u>	<u>80-20</u>
Whole Body	150 mrem/yr	170 mrem/yr	240 mrem/yr	260 mrem/yr
Bone Marrow	170 mrem/yr	190 mrem/yr	280 mrem/yr	300 mrem/yr

NOTE: On attachments 7-8 it is assumed that the maximum exposed individuals would be three times these values as per the FRC guidance.

Calculated 30-Year Dose (Average Whole Body)  
(Federal guidance is 5000 mrem/30 yrs)

- A. People live 100% of the time on Eneu Island.

<u>With Food Imports</u>	<u>Without Food Imports</u>
2700 mrem	4700 mrem

- B. People live 90% of the time on Eneu Island and visit Bikini Island 10% of the time, or 80% of the time is spent on Eneu Island and 20% of the time is spent on Bikini Island, and assuming that no food from Bikini Island is eaten.

<u>With Food Imports</u>		<u>Without Food Imports</u>	
<u>90-10</u>	<u>80-20</u>	<u>90-10</u>	<u>80-20</u>
3200 mrem	3700 mrem	5200 mrem	5700 mrem

NOTE: People who recently lived on Bikini Island already have received a dose of about 1000 mrem. This has not been included in the above estimates

- <sup>15</sup>The dietary parameters are important factors in the calculation of dose estimates, and the diet is continually being refined as additional information becomes available. To the extent that the diet used in this document (Attachment 1) may be refined, or that dietary practices may change, the dose estimate may also change accordingly.

If there is increased utilization of Bikini Island, the projected doses can be estimated by applying the finding that the respective Bikini doses would be about eight to ten times the doses for Eneu residence shown above (maximum annual and 30-year doses).<sup>16</sup>

If return to Eneu and Bikini is delayed, the above dose estimate would be reduced by a factor of two for every 30-year period the return is delayed. This is due to the fact that the radioactivity of the two radionuclides (cesium-137 and strontium-90) that contribute most to whole body and bone marrow doses, decays in the environment with an effective half-time of 30 years.

Attachments 5 and 6 present estimates of the maximum annual whole body and bone marrow doses for the average population if, starting with 1979 as the zero time, a return to live on Eneu Island (the six lower curves) or on Bikini Island (the two highest curves) is delayed. Attachments 7 and 8 present similar information for the individuals receiving the highest doses. Attachment 9 shows the predictions for 30-year doses.

#### DISCUSSION

The predicted maximum annual whole body and bone marrow doses for the average Eneu Island population in Attachments 5 and 6 can be compared with the 170 mrem/yr federal guidance. If a monitoring program

<sup>16</sup>The basis for this estimate is that the concentrations of radionuclides in the soil and in coconuts on Bikini are about eight to ten times greater than those on Eneu. Therefore, consumption of foods grown on Bikini Island would increase the annual dose rate estimates significantly, increase depending upon the type and quantity of food eaten. Estimates based upon assumed combinations of Eneu and Bikini foods, and imported foods, other than those included herein, can be provided if needed.

is in place, doses to the highest individuals can be compared with the standard for individuals which is 500 mrem/yr (see Attachments 7 and 8). Doses for the highest individuals can also be compared with the Enevetak criterion which is 250 mrem/yr.

Whether annual doses (for the population or for individuals) and 30-year doses for people living on Eneu or Bikini Islands meet or exceed federal guidance and/or the recently developed Enevetak criteria depends upon the amount, kind, and source of local foods that are eaten, the availability of imported foods, the proportion of residence time on Eneu Island and on Bikini Island, and the time interval between now and the date of rehabilitation.

Attachments 5 through 9 illustrate the estimated dose (vertical axis) to the population or to an individual in the population if the people are returned to Eneu or to Bikini in any particular year (horizontal axis, beginning in 1979). Moreover, the attachments illustrate estimated doses for eight separate living patterns as identified on Attachment 5. Federal guidance and Enevetak criteria levels also are indicated. If any particular curve does not go above the guidance or criteria level, a return of the people could be accomplished that year without expecting to exceed the guidance or criteria, providing residence conforms to the conditions upon which the doses are estimated. If a curve goes above the guidance or criteria, the point at which it crosses the guidance or criteria, as read from the horizontal axis, is the approximate number of years that return should be delayed so that the radiation dose would not be expected to exceed the guidance or criteria.

For example, if the Bikinians returned in 1979 to Eneu, if the diet consists of both local and imported foods as shown in Attachment 1, and if they spend no time on and consume no food from Bikini Island, (Attachments 5-9, Curve 1) their predicted maximum annual whole body and bone marrow doses and their 30-year whole body doses (average for the population) would be within the federal guidance of 170 mrem/yr and 5000 mrem/30 yr. Under these same conditions, exposures of the highest individuals would be within the 500 mrem/yr federal guidance for whole body and bone marrow but would exceed the 250 mrem/yr Enevetak criterion. Without imported food (Attachments 5-9, Curve 4) both predicted average population and highest individual doses exceed the 170 and 500 mrem/yr federal guidance, while the 30-year estimate of 4700 mrem/30 yr just meets the 5000 mrem/30 yr federal guidance but exceeds the 4000 mrem/30 yr Enevetak criterion.

Furthermore, it must be recognized that there is a significant degree of uncertainty in the dose estimates because of the need to predict lifestyles of peoples. For most situations it is estimated that these values may be realistic to within a factor of two; under unusual circumstances they may be within a factor of three.<sup>17</sup> These, then, would be the approximate error bands associated with the curves in Attachments 5-9.

A summary comparison of these curves with the federal guidance and with the Enevetak criteria is given in Attachment 10.

<sup>17</sup>Robison, W.L. and Phillips, W.A., "An Updated Radiological Dose Assessment of Eneu Island at Bikini Atoll, UCRL-52775, 1979, in draft.

# OTHER CONSIDERATIONS

In evaluating radiological conditions on Eneu and Bikini Islands,

there are certain other factors which should be taken into account:

1. Exposure to any radiation is believed to involve some risk which is proportionally greater as the radiation exposure increases; therefore, any unnecessary radiation exposures should be avoided and all exposures kept as low as is reasonably achievable.

2. The benefits and risks inherent in the Federal guidance are those applicable to persons living outside of restricted access areas in the U.S. under normal peacetime operations.

3. There appear to be difficulties associated with the practicality and reliability of applying administrative controls over long periods of time with the intent to limit exposure.

4. The need to apply a safety factor where there are uncertainties in the predicted dose estimates, resulted in the use of a factor of 2 in applying Federal guidance to the Enewetak situation.

5. The marketability for copra produced from coconuts grown on Bikini and Eneu Islands is questionable at the present time.

There are also nonradiological factors which have not been considered.

Among these are:

1. The benefits to be derived by the Bikini people in returning to their Atoll according to their own decisions and preferences.

2. Resettlement options at locations other than Bikini Atoll.

3/21/79

## DIETS

ENEU ISLAND AND IMPORTED FOODS		ENEU ISLAND FOODS ONLY		IMPORTED FOODS	
	INTAKE G/DAY		INTAKE G/DAY		INTAKE G/DAY
FISH	300	FISH	600	FISH	300
DOMESTIC MEAT	20	DOMESTIC MEAT	50	DOMESTIC MEAT	20
PAIDARIUS FRUIT	15	PAIDARIUS FRUIT	75	PAIDARIUS FRUIT	15
BREADFRUIT	100	BREADFRUIT	200	BREADFRUIT	100
WILD BIRDS	-	WILD BIRDS	10	WILD BIRDS	-
BIRD EGGS	-	BIRD EGGS	5	BIRD EGGS	-
COCOAUT FLUID	200	COCOAUT FLUID	300	COCOAUT FLUID	200
COCOAUT MEAT	50	COCOAUT MEAT	100	COCOAUT MEAT	50
CLAYS	15	CLAYS	25	CLAYS	15
GARDEN FRUITS AND VEGETABLES	30	GARDEN FRUITS AND VEGETABLES	50	GARDEN FRUITS AND VEGETABLES	30
TOTAL	825	TOTAL	1415	TOTAL	825
1630					



CONCENTRATION OF  $^{137}\text{Cs}$  IN SUBSISTENCE CROPS AND FISH AT BIKINI ISLAND

Attachment 2

FOOD PRODUCT	NO. OF SAMPLES	AVERAGE CONCENTRATION PC/G NET WEIGHT	RANGE OF CONCENTRATION PC/G NET WEIGHT
COCONUT MEAT (GREEN)	6	22.7	3.5-48
COCONUT MEAT (INTER-MEDIATE)	9	16.5	4.8-32
COCONUT MEAT (MATURE)	31	30.9	5.3-117
COCONUT MEAT (SPROUTED, SPRINKY)	8	27	16-52
ALL COCONUT MEAT	54	27	3.5-117
COCONUT FLUID	28	13.5	1.2-44
BREADFRUIT	2	6.5	5.2-7.8
SQUASH	12	8.5	1.6-20
PAPAYA	18	14	1.6-31
BANANA	3	0.92	0.54-1.3
SWEET POTATO	2	3.6	2.3-5
WATERMELON	17	2.6	0.26-7.2
GARDEN FRUITS AND VEGETABLES (AVERAGE OF SQUASH, PAPAYA, BANANA, SWEET POTATO, WATERMELON)		5.9	
FISH (MULLET)*	6	0.026*	
DOMESTIC MEAT		15*	

\* FROM V. NOSIKIN

• ESTIMATED FROM BIKINI FIG DATA

Attachment 3

CONCENTRATION OF  $^{90}\text{Sr}$  IN SUBSISTENCE CROPS AND FISH AT BIKINI ISLAND

FOOD PRODUCT	NO. OF SAMPLES	AVERAGE CONCENTRATION PC/G NET WEIGHT	RANGE OF CONCENTRATION PC/G NET WEIGHT
COCONUT MEAT	9	0.021	0.0033 - 0.052
COCONUT FLUID*	-	0.021*	-
BREADFRUIT	2	1.9	0.47 - 3.4
WATERMELON	8	0.031	0.012 - 0.063
SQUASH	6	0.054	0.024 - 0.15
PAPAYA	5	0.29	0.052 - 0.39
SWEET POTATO	1	0.13	-
GARDEN FRUITS AND VEGETABLES (AVERAGE OF WATERMELON, SQUASH, PAPAYA, SWEET POTATO)		0.13	
FISH (MULLET)		0.076*	
CLAMS		0.005*	
DOMESTIC MEAT		0.011**	

\* ASSUMED TO BE THE SAME AS COCONUT MEAT

+ FROM V. NELSON AND B. SCHELL

\*\* FROM 1975 BIKINI DOSE ASSESSMENT

CONCENTRATION OF  $^{239+240}\text{Pu}$  IN SUBSISTENCE CROPS AND FISH AT ENEU ISLAND

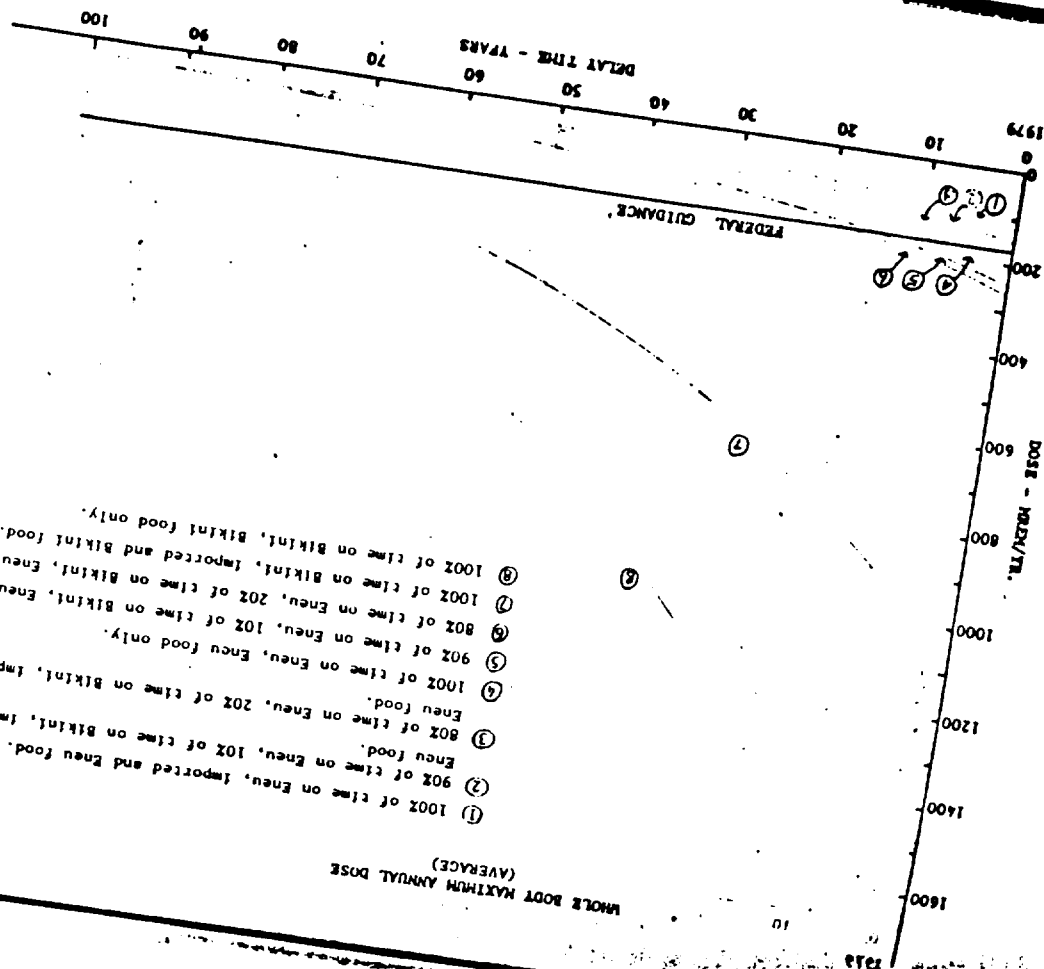
Attachment 4

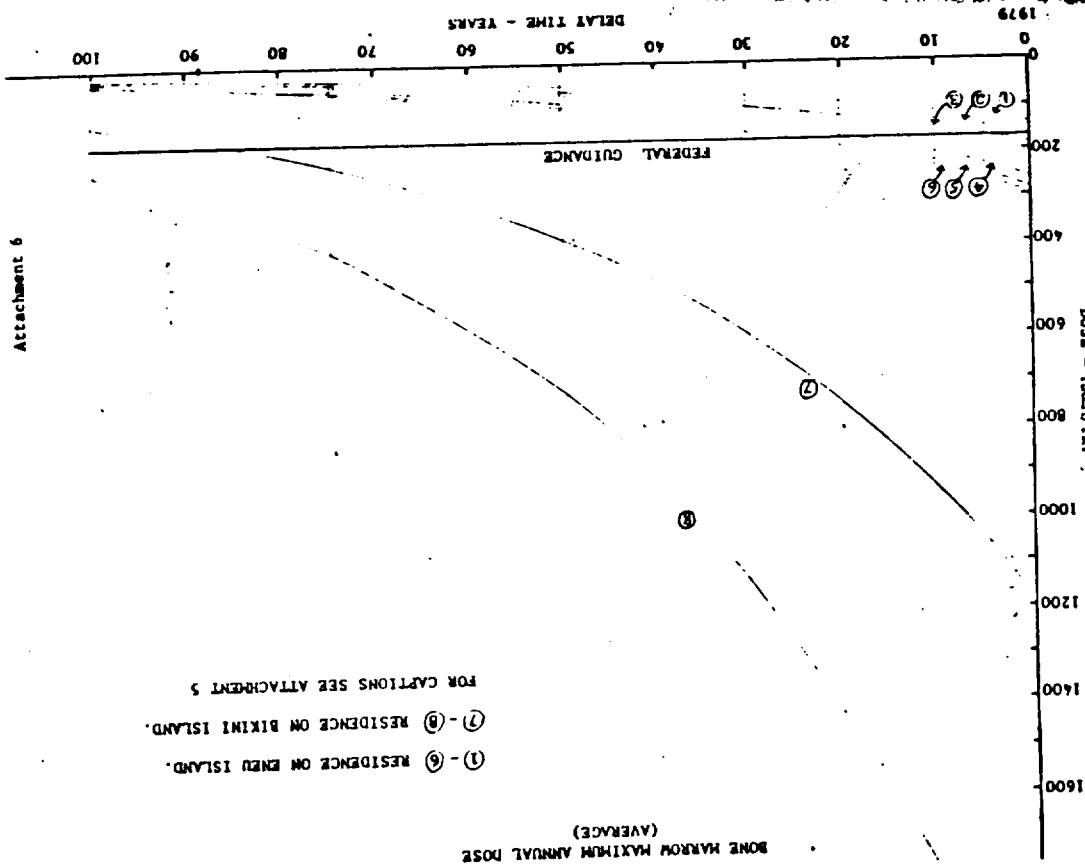
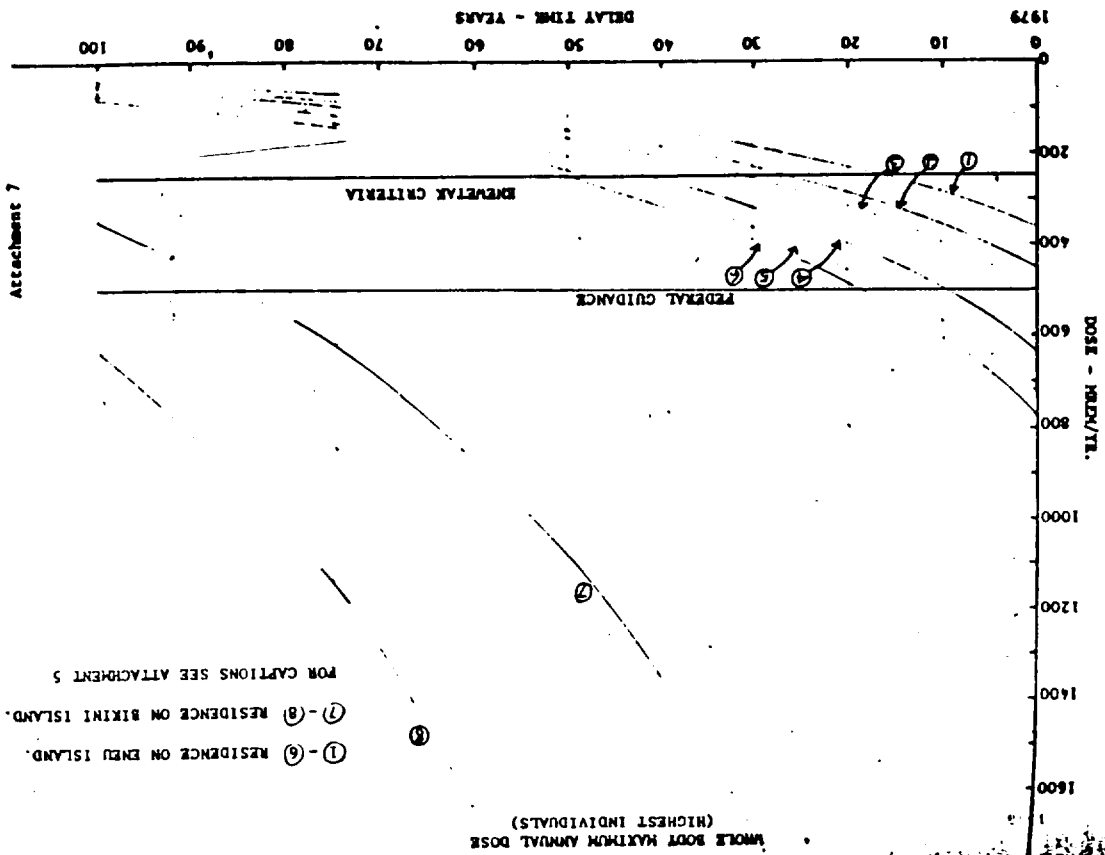
FOOD PRODUCT	NO. OF SAMPLES	AVERAGE CONCENTRATION: PC/G NET WEIGHT	RANGE OF CONCENTRATION: PC/G NET WEIGHT
COCONUT MEAT	9	$2.8 \times 10^{-5}$	
COCONUT FLUID	-	$2.8 \times 10^{-5}$	$4.1 \times 10^{-6} - 5.3 \times 10^{-5}$
BREADFRUIT	1	$1.7 \times 10^{-5}$	
WATERMELON	8	$1.3 \times 10^{-5}$	
SQUASH	6	$8 \times 10^{-6}$	
PAPAYA	3	$8.3 \times 10^{-6}$	$4.4 \times 10^{-6} - 2.0 \times 10^{-5}$
GARDEN FRUITS AND VEGETABLES (AVERAGE OF WATERMELON, SQUASH, PAPAYA)		$9.8 \times 10^{-6}$	$3.5 \times 10^{-6} - 1.9 \times 10^{-5}$
FISH (TILLET)*	6	$1.3 \times 10^{-4}$	$6.5 \times 10^{-6} - 1.1 \times 10^{-5}$

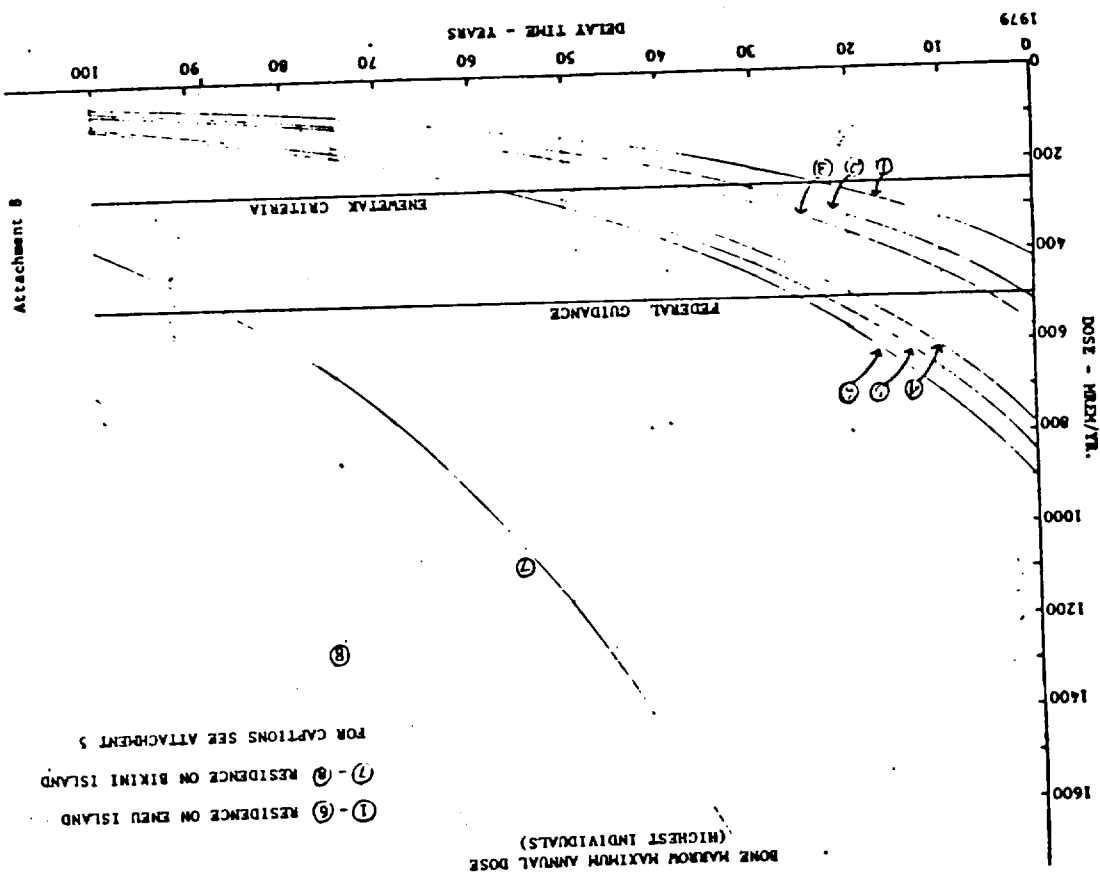
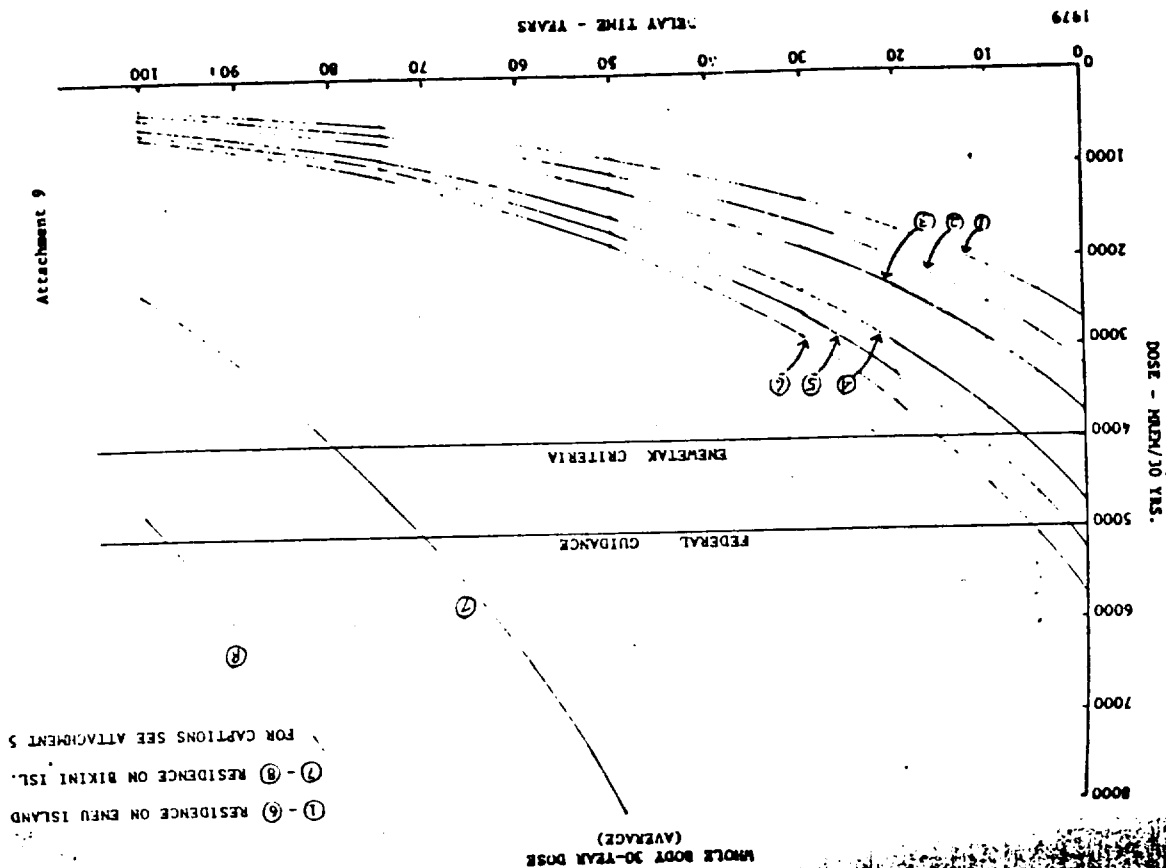
\* ASSUMED TO BE THE SAME AS COCONUT MEAT  
+ FROM V. NOSHIN

Attachment 5

- WHOLE BODY MAXIMUM ANNUAL DOSE (AVERAGE)
- (1) 100% of time on Eneu, imported and Eneu food.
  - (2) 90% of time on Eneu, 10% of time on Bikini, imported and Eneu food.
  - (3) 80% of time on Eneu, 20% of time on Bikini, imported and Eneu food.
  - (4) 100% of time on Eneu, Eneu food only.
  - (5) 90% of time on Eneu, 10% of time on Bikini, Eneu food only.
  - (6) 80% of time on Eneu, 20% of time on Bikini, Eneu food only.
  - (7) 100% of time on Bikini, imported and Bikini food.
  - (8) 100% of time on Bikini, Bikini food only.







Living/Eating Pattern	COMPLIANCE OF ESTIMATED DOSES* TO				
	FEDERAL GUIDELINES		ENEWETAK CRITERIA		
	Population	Individual	Individual		
	170 mrem/yr	5000 mrem/30 yrs	500 mrem/yr	250 mrem/yr	4000 mrem/30 yrs
With Food Imports Plus Eneu Food					
100% of Time on Eneu	YES	YES	YES	NO (~20-25 Yrs)	YES
90% of Time on Eneu, 10% on Bikini	Borderline	YES	Borderline	NO (~30-35 Yrs)	YES
80% of Time on Eneu, 20% on Bikini	NO (up to 5 Yrs)	YES	NO (~5-10 Yrs)	NO (~35-40 Yrs)	YES
With No Food Imports; Eneu Food Only					
100% of Time on Eneu	NO (~15-20 Yrs)	YES	NO (~15-20 Yrs)	NO (~45-50 Yrs)	NO (~5-10 Yrs)
90% of Time on Eneu, 10% on Bikini	NO (~20-25 Yrs)	NO (up to 5 Yrs)	NO (~20-25 Yrs)	NO (~50-55 Yrs)	NO (~10-15 Yrs)
80% of Time on Eneu, 20% on Bikini	NO (~20-25 Yrs)	NO (~5-10 Yrs)	NO (~20-25 Yrs)	NO (~55-60 Yrs)	NO (~15-20 Yrs)

\*Number in parentheses is the approximate range of the number of years until the indicated living/eating pattern is estimated to be in compliance with the guidance/criteria.

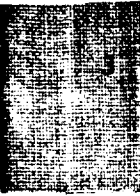


Table 23. Maximum annual dose rates in millirems per year for adults for a living pattern consisting of 100% time on Bikini Island and all locally grown foods from Bikini Island.

Organ	Radionuclide ingestion <sup>a</sup>	External gamma <sup>b</sup>	Total	Year of maximum dose
<u>Imports available</u>				
Whole body	815	189	1000	3
Bone marrow	845	189	1030	3
<u>Imports unavailable</u>				
Whole body	1685	189	1870	3
Bone marrow	1775	189	1960	3

<sup>a</sup> Whole-body ingestion dose from <sup>137</sup>Cs. Bone-marrow ingestion dose from <sup>137</sup>Cs and <sup>90</sup>Sr.

<sup>b</sup> Background subtracted.

Table 24. Maximum annual dose rates in millirems per year for adults for a living pattern consisting of 100% time on Eneu Island and all locally grown foods from Eneu Island.

Organ	Radionuclide ingestion <sup>a</sup>	External gamma <sup>b</sup>	Total	Year of maximum dose
<u>Imports available</u>				
Whole body	116	14	130	3
Bone marrow	122	14	140	3
<u>Imports unavailable</u>				
Whole body	231	14	250	3
Bone marrow	249	14	260	3

<sup>a</sup> Whole-body ingestion dose from <sup>137</sup>Cs. Bone-marrow ingestion dose from <sup>137</sup>Cs and <sup>90</sup>Sr.

<sup>b</sup> Background subtracted.

Table 25. Maximum annual dose rates in millirems per year for adults for a living pattern consisting of 50% of the diet and time associated with Eneu Island and the other 50% associated with Bikini Island.

Organ	Radionuclide ingestion <sup>a</sup>	External gamma <sup>b</sup>	Total	Year of maximum dose
<u>Imports available</u>				
Whole body	465	102	570	3
Bone marrow	483	102	590	3
<u>Imports unavailable</u>				
Whole body	958	102	1060	3
Bone marrow	1012	102	1110	3

<sup>a</sup> Whole-body ingestion dose from <sup>137</sup>Cs. Bone-marrow ingestion dose from <sup>137</sup>Cs and <sup>90</sup>Sr.

<sup>b</sup> Background subtracted.

Table 26. Maximum annual dose rates in millirems per year for adults for a living pattern consisting of 90% time on Eneu Island and 10% time on Bikini Island and all locally grown foods from Eneu Island.

Organ	Radionuclide ingestion <sup>a</sup>	External gamma <sup>b</sup>	Total	Year of maximum dose
<u>Imports available</u>				
Whole body	116	32	150	3
Bone marrow	122	32	150	3
<u>Imports unavailable</u>				
Whole body	231	32	260	3
Bone marrow	249	32	280	3

<sup>a</sup> Whole-body ingestion dose from <sup>137</sup>Cs. Bone-marrow ingestion dose from <sup>137</sup>Cs and <sup>90</sup>Sr.

<sup>b</sup> Background subtracted.



Table 28. The 30-y integral doses in rem for adults for a living pattern consisting of 100% time on Eneu Island and all locally grown foods from Eneu Island.

Pathway and radionuclide	Imports available		Imports unavailable	
	Whole body	Bone marrow	Whole body	Bone marrow
Ingestion				
$^{137}\text{Cs}$	2.6	2.6	5.2	5.2
$^{90}\text{Sr}$	--	0.2	--	0.61
$^{239+240}\text{Pu}^a$	--	0.00044	--	0.0015
$^{241}\text{Am}^a$	--	0.0014	--	0.0044
External gamma <sup>b</sup>				
$^{137}\text{Cs} + ^{60}\text{Co}$	0.32	0.32	0.32	0.32
Inhalation <sup>a</sup>				
$^{239+240}\text{Pu}$	--	0.0096	--	0.0096
$^{241}\text{Am}$	--	0.0065	--	0.0065
$^{241}\text{Pu} (^{241}\text{Am})$	--	0.0015	--	0.0015
TOTAL	2.9	3.1	5.5	6.1

<sup>a</sup>Doses to mineral bone not bone marrow; bone-marrow doses approximately one fourth of these values.

<sup>b</sup> Background subtracted.

Table 30. The 30-y integral doses in rem for adults for a living pattern consisting of 90% time on Eneu Island and 10% on Bikini Island and all locally grown foods from Eneu Island.

Pathway and radionuclide	Imports available		Imports unavailable	
	Whole body	Bone marrow	Whole body	Bone marrow
Ingestion				
$^{137}\text{Cs}$	2.6	2.6	5.2	5.2
$^{90}\text{Sr}$	--	0.2	--	0.61
$^{239+240}\text{Pu}^a$	--	0.00044	--	0.0015
$^{241}\text{Am}^a$	--	0.0014	--	0.0044
External gamma <sup>b</sup>				
$^{137}\text{Cs} + ^{60}\text{Co}$	0.71	0.71	0.71	0.71
Inhalation <sup>a</sup>				
$^{239+240}\text{Pu}$	--	0.021	--	0.021
$^{241}\text{Am}$	--	0.02	--	0.02
$^{241}\text{Pu} (^{241}\text{Am})$	--	<u>0.0034</u>	--	<u>0.0034</u>
TOTAL	3.3	3.5	6.1	6.5

<sup>a</sup> Doses to mineral bone not bone marrow; bone-marrow doses approximately one fourth of these values.

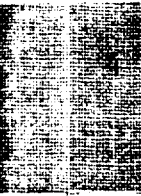
<sup>b</sup> Background subtracted.

Table 32. The 50-y integral doses in rem for adults for a living pattern consisting of 100% time on Eneu Island and all locally grown foods from Eneu Island.

Pathway and radionuclide	Imports available		Imports unavailable	
	Whole body	Bone marrow	Whole body	Bone marrow
Ingestion				
$^{137}\text{Cs}$	3.6	3.6	7.2	7.2
$^{90}\text{Sr}$	--	0.28	--	0.86
$^{239+240}\text{Pu}^a$	--	0.0012	--	0.0041
$^{241}\text{Am}^a$	--	0.0036	--	0.012
External gamma <sup>b</sup>				
$^{137}\text{Cs} + ^{60}\text{Co}$	0.44	0.44	0.44	0.44
Inhalation <sup>a</sup>				
$^{239+240}\text{Pu}$	--	0.029	--	0.029
$^{241}\text{Am}$	--	0.017	--	0.017
$^{241}\text{Pu} (^{241}\text{Am})$	--	<u>0.0057</u>	--	<u>0.0057</u>
TOTAL	<u>4</u>	<u>4.3</u>	<u>7.6</u>	<u>8.5</u>

<sup>a</sup> Doses to mineral bone not bone marrow; bone-marrow doses approximately one fourth of these values.

<sup>b</sup> Background subtracted.

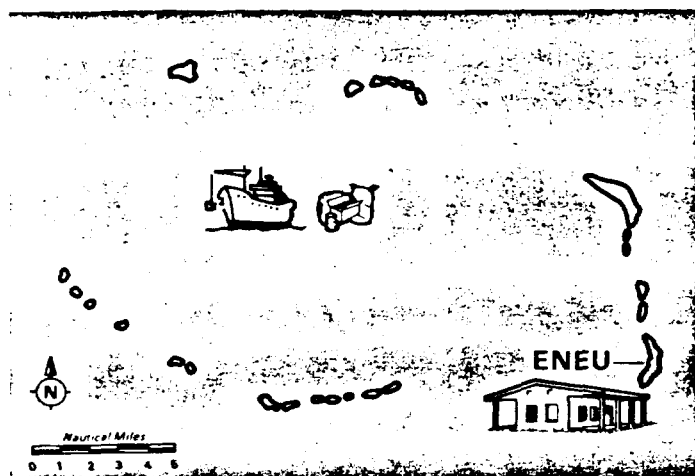


# Melele ko Retōbrak

Elañe 550 armij renaj jokwe wōt ilo Eneu im jab ilok ñōn ene ko jet, im mōñā mōñā ko jen Eneu wōt na ibben mōñā ko jen ailiñ ko ilikin:

## Information that has been obtained

If 550 people will live on Eneu Island and not go to the other islands, and eat food only from Eneu Island along with imported food



Joñan radiation eo elaptata juñ armij  
emaroñ bwelen bōke iumin juñ yō ..... 390 millirem  
The largest amount of radiation one person might receive during 1 year

Joñan radiation eo iolap (average) juñ armij  
emaroñ bwelen bōke iumin 30 yō:  
ilo aolepen enbwinnin (whole body) ..... 2,800 millirem  
ilo nonnonmej ilaoñ dri (bone marrow) ..... 3,000 millirem  
Average amount of radiation a person might receive during 30 years

Oran armij ro remaroñ bwelen mij jen cancer  
iumin yō kein 30 rej itok, emaroñ lōñlok  
kin joñan in ..... 0.3 lok ñōn 1  
The number of people who might die from cancer during the next 30 years might increase by this amount ..... from 0.3 to 1

Melelen, bwe elañe enaj wor 24 armij remij ilo yō kein 30 iman jen jabrewōt cancer ijellokin cancer ko rej walok jen radiation eo ej walok jen atomic bomb, emaroñ bar kobatok 0.3 ñōn 1 eo ej mij jen cancer ko rej walok jen radiation eo ej walok jen atomic bomb.

This means that if there would be 24 people die within the next 30 years from any cancer other than that caused by radiation left from atomic bombs, there might be an additional 0.3 to 1 who die from cancer that is caused by radiation left from atomic bombs.

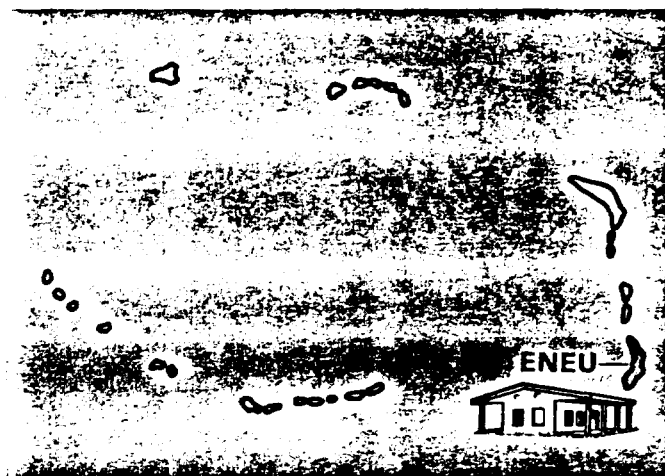
Joñan lōñlok in ajiri ro remaroñ bwelen lotaktok kin  
nañinmij ak utamwe ilo yō kein 30 rej itok ..... 0.8  
The possible increase of children born with health defects within the next 30 years

Melelen, bwe elañe enaj wor 140 ajiri ro rej lotaktok kin nañinmij ak utamwe walok jen jabrewōt un ko ijellokin radiation eo ej walok jen atomic bomb ilo yō kein 30 iman, emaroñ bar kobatok 0.8 eo ej lotaktok kin nañinmij ak utamwe walok jen radiation eo ej walok jen atomic bomb.

This means that if there were 140 children born with health defects occurring from any cause other than radiation left from atomic bombs, within the next 30 years, there might be an additional 0.8 children born with defects caused by radiation left from atomic bombs.

Elañe 550 armij renaj jokwe wōt ilo Eneu im jab ilok ñōn ene ko jet, im mōñā wōt mōñā ko jen Eneu:

If 550 people will live on Eneu Island and not go to the other islands, and eat food only from Eneu Island



..... 780 millirem

..... 5,400 millirem  
..... 6,000 millirem

..... 0.5 lok ñōn 3

Melelen, bwe elañe enaj wor 24 armij remij ilo yō kein 30 iman jen jabrewōt cancer ijellokin cancer ko rej walok jen radiation eo ej walok jen atomic bomb, emaroñ bar kobatok 0.5 ñōn 3 ro rej mij jen cancer ko rej walok jen radiation eo ej walok jen atomic bomb.

This means that if there would be 24 people die within the next 30 years from any cancer other than that caused by radiation left from atomic bombs, there might be an additional 0.5 to 3 who die from cancer that is caused by radiation left from atomic bombs.

..... 2

Melelen, bwe elañe enaj wor 140 ajiri ro rej lotaktok kin nañinmij ak utamwe walok jen jabrewōt un ko ijellokin radiation eo ej walok jen atomic bomb ilo yō kein 30 iman, emaroñ bar kobatok 2 ajiri rej lotaktok kin nañinmij ak utamwe walok jen radiation eo ej walok jen atomic bomb.

This means that if there were 140 children born with health defects occurring from any cause other than radiation left from atomic bombs, within the next 30 years, there might be an additional 2 children born with defects caused by radiation left from atomic bombs.



Enen jokwe  
Island for living



Mōñā ko jen  
ailiñ ko ilikin  
Imported foods



Mōñā ko  
jen eneo  
Food from  
this island





Pacific Northwest Laboratories  
P.O. Box 994  
Richland, Washington U.S.A. 99352  
Telephone (509) 375-2421  
Telex 15-2874

September 12, 1984

Mr. Roger Ray  
Nevada Operations Office  
Department of Energy  
2753 S Highland Drive  
Las Vegas, NV 89114

ACTION SD  
INFO \_\_\_\_\_  
R.F. \_\_\_\_\_  
AMA \_\_\_\_\_  
AME & S \_\_\_\_\_  
AMO \_\_\_\_\_

Dear Roger:

The following is a brief report on the meeting to review the dosimetric data from the Marshall Islands held in Richland on August 28, 1984.

SUMMARY

Date: August 28, 1984

Participants:

Barbara Boccia	Brookhaven National Laboratory
Keith Eckerman	Oak Ridge National Laboratory
Jack Healy	Los Alamos National Laboratory
Edward Lessard	Brookhaven National Laboratory
Roger Ray	DOE Nevada Operations Office
William Robison	Lawrence Livermore National Laboratory
William Templeton	Pacific Northwest Laboratory
Roy Thompson	" " "
William Bair	" " "

Purpose:

To review the current status of predicted and actual radiation exposures of Marshall Islanders, particularly as these might relate to potential resettlement of Eneu Island in the Bikini Atoll.

Summary of the Discussion and Conclusions:

Comparisons presented of radiation doses based on in-vivo counting measurements versus doses predicted from radionuclide intake models for Marshall Islanders at Utirik and the southern islands of Rongelap

Letter to Roger Ray  
September 12, 1984  
Page 2

showed excellent agreement. This agreement between measured and predicted levels constitutes an important overall validation of models employed in the predictions -- including physical, biological, and cultural aspects of these models. Publication of this validation was recommended. The accumulation of data and the validation of models in recent years would seem to remove any reluctance to apply applicable U.S. limits to the Marshall Islanders.

An area of remaining uncertainty relates to the transuranic elements, principally plutonium and americium, where very limited bioassay data on plutonium excretion yielded much higher radiation dose values than predicted by models. This is not considered a serious complication because the transuranics are not predicted to contribute importantly to the total radiation dose, and analytical problems involving natural polonium in the urine samples seem to offer a plausible explanation of the bioassay problem. This problem is being intensively studied and a resolution may be anticipated within 3 to 6 months -- perhaps sooner. To assist in this, information on plutonium bioassay methods and the Leggett and Moss dosimetric models is being forwarded to Dr. Lessard.

With respect to the potential resettlement of Eneu, based on the best current evidence, it still seems unlikely that an Eneu resident, consuming a mix of local and imported foods (but no significant quantity from the Island of Bikini), would exceed an exposure of 500 mrem per year.

Sincerely yours,



W. J. Bair, Ph.D.  
Manager  
Environment, Health and  
Safety Research Program

WJB:lm

cc: Tom Clark, NVO  
Participants





**Battelle**

Pacific Northwest Laboratories  
P.O. Box 999  
Richland, Washington U.S.A. 99352  
Telephone (509) 375-2421  
Telex 15-2674

September 14, 1984

Mr. Tommy F. McCraw  
Office of Environment, Safety  
and Health  
Office for Policy, Safety and  
Environment  
Department of Energy  
PE-24, GTN  
Germantown, MD 20545

Dear Tommy:

Enclosed is a copy of the report on the meeting we had in Richland to review the Marshalllese dose data. We all felt the plutonium issue is resolvable and that the Brookhaven and Livermore values will be in reasonably close agreement when the analytical questions have been settled.

The highlight of the meeting may have been Ed Lessard's summarizing data that demonstrates validation of the predictive models used by Livermore. Remembering the many discussions about the reasonableness of the dietary models used, this is an important accomplishment. The following are the data summarized by Ed Lessard in Richland. I have not tried to extract these Brookhaven values from the Health Physics article. I believe plutonium values are omitted in all of the following values.

	1978 (Annual dose, mrem/year)		1978-2008 (30 year dose, rem)	
	BNL	LLNL	BNL	LLNL
Rongelap	35 to 135	50/120	0.76 to 2.5	0.64/1.2
Utirik	3 to 29	12/29	0.25 to 0.72	0.17/0.43

Brookhaven - Health Physics 46, 1984: values are ranges of effective dose equivalents

Livermore - UCRL-52853, Part 4: values are mean and maximum dose equivalents

Letter to T. McCraw  
September 14, 1984  
Page 2

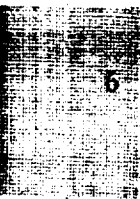
I understand from Roger that you and Joe Deal are meeting with him on Friday.

With best regards,

A handwritten signature in cursive script, appearing to read "Bill".

W. J. Bair, Ph.D.  
Manager  
Environment, Health and  
Safety Research Program

cc: Roger Ray



## Draft Letter to the Secretary of the Interior

Dear Mr. Secretary:

This is in response to your request that the Department of Energy update its 1979 evaluation of the habitability of Eneu Island in Bikini Atoll and inform you of what conditions, if any, should be imposed upon a population which may resettle on that island.

Since the writing of the May 15, 1979, letter from Assistant Secretary Clusen, referred to in your letter to me, we have continued our environmental studies at Bikini Atoll and elsewhere in the Marshall Islands. We have a high degree of confidence in the technical data upon which our evaluations are made.

There remain uncertainties, especially regarding human behavior (viz: What is likely to be the composition of the diet of a resettled Eneu population?) and some unknowns, especially as to the response of individuals to given doses of radiation. Customarily, these latter--the unknowns--are dealt with by building conservatism into our radiation protection guidance. The behavioral uncertainties can be treated similarly--that is, by adding yet another degree of conservatism in the application of the guidance, as was done some years ago in setting criteria for the Enewetak cleanup at 50 percent of the annual Federal guide. Since that time, however, our confidence has increased in our knowledge of the radiological conditions in the Northern Marshall Islands and in the validity of our predictive models. In fact, for the most significant radionuclides of interest, actual measurements of body burdens in the resident populations of three different atolls have confirmed the validity of the models and of our dose predictions. Because of the very low levels of

plutonium in the Bikini environment and the consequent difficulty in making plutonium measurements, we cannot yet assign a precise value to the dose attributable to that element. We are continuing our examination of this question, but for the purpose of this evaluation we can say with confidence that the annual dose due to plutonium will be predicted, at most, at only a few percent of the total dose as discussed here. We estimate that our plutonium work will continue for three to six more months. Meanwhile, with our current level of understanding and confidence, the application of the Enewetak 50 percent criterion is no longer justified. The Eneu situation should thus be evaluated against the 500 mrem/yr (5 rem/30 yr) guideline.

The most recent information regarding dose and risk which has been provided the Bikini people is contained in a bilingual book entitled "The Meaning of Radiation at Bikini Atoll." A copy of that book is enclosed with this letter. On page 21, full-time residence on Eneu is discussed, with two alternative cases: (a) with imported food available, and (b) with only Eneu-grown food available. The expected doses and their predicted consequences are tabulated. The largest predicted one year dose for an individual is 390 mrem in case a; 780 mrem in case b. (It is noted that this dose may not actually be received by any individual. The average dose to the population, and therefore the most likely dose to an individual, would be approximately 1/3 of this largest predicted dose.) The 30 year average dose to this population is predicted to be about 3 rem. These published predictions assumed that residence on Eneu would begin in January 1981. With the principal radionuclides having decay half lives in the neighborhood of 30 years, these predicted doses should be adjusted for the actual resettlement date. For a date of, say, January 1986, the resultant doses would be reduced by about 11 percent. Thus, with imported

foods available, a population resettled on Eneu would be expected to stay within the U.S. Federal guidelines for radiation exposure.

Our observations and our experience in recent years lead us to conclude that the use of imported foods as a substantial fraction of the Marshallese diet is a reasonable assumption. In fact, we have observed, at Rongelap and Utirik, and more recently at Enewetak, a distinct preference for a mix including imported foods over an exclusively locally produced diet, especially if the imported foods are well chosen. We would expect this apparent preference to be reinforced by authoritative dietary recommendations.

There remains the question of assuring that Bikini Island does not become a significant food source to people resettled on Eneu (Bikini, in this sense has been referred to as an "attractive nuisance"). Surely there exists the possibility that Eneu residents may visit Bikini Island and partake of some local foods. We believe that this is a matter for the people themselves, and their leaders, to evaluate. Our obligation, we believe, is to educate and inform the subject population of the risks associated with various radiation doses and of methods of avoiding unnecessary exposures. Although we must acknowledge some evidence, from Enewetak, that our recommendations are not uniformly and rigidly followed, we have convincing long-term evidence from Rongelap that people are following recommendations restricting the use of foods from the northern islands. Nevertheless, there may well be some individuals who, notwithstanding advice to the contrary, will visit Bikini Island. Such individuals will sustain higher radiation doses than they would otherwise. Brief visits, especially if Bikini foods are not eaten, will not appreciably change the dose prediction, but if visits are extended and include

consumption of local foods, the doses will rise rapidly. For example, if 50 percent of the time and diet is on Bikini Island the theoretical average individual who would have been predicted to have a maximum year dose on Eneu of 115 mrem would now be predicted slightly above the Federal guideline at about 510 mrem, and some individuals would be expected to substantially exceed that dose.

We do have proven techniques for monitoring adherence to dietary recommendations. These, usually referred to as bioassay techniques, would be applicable to the Eneu situation, and their continued availability is provided for under the technical assistance provision of the Section 177 Agreement subsidiary to the Compact of Free Association.

To summarize, a population resettled on Eneu at this time would inevitably be subjected to radiation exposures which are higher than those which they now encounter at Kili and Ejit, but with reasonable care their dose commitment would be within the range of that which goes without notice in many other parts of the world and is within U.S. Federal guidelines.

It is assumed that, following resettlement, regular field trip service to Bikini Atoll would be maintained, and therefore that both imported and local foods would be available. Under this assumption, the Department of Energy would recommend the following conditions upon resettlement:

- a. Residence should be restricted to Eneu Island.

b. Locally grown terrestrial foods should be taken from Eneu Island only.

c. At least for the first several years a monitoring program should be conducted to evaluate, and report to the appropriate authorities on, the actual radiological aspects of the resettlement.

Should you decide to authorize or facilitate an Eneu resettlement, we will be pleased to assist with detailed planning and implementation.

Sincerely,

Donald Paul Hodel

Enclosure

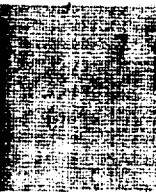
Roger Ray, NV

(702) 295-3553

FTS 575-3553

September 11, 1984





9/21/84

DRAFT

STAFF COMMENTS

1. There are three populations in the MI's that have been overexposed. Some doses were very high.
2. US H&S standards apply in the Marshalls.
3. We have underestimated Bikini resettlement doses repeatedly using dose models and at time when it was necessary to have reliable estimates for resettlement decisions. PE staff believe that this experience does not justify statements that DOE has a high degree of confidence in its technical data nor can there be such confidence in exposure predictions using dose models.
4. Dietary restrictions did not work at Bikini Island. It is our view that such restrictions and imported food will also not achieve any significant reduction in the major source of exposure, namely the use of coconuts products, at Eneu Island.

RESPONSE TO PE STAFF COMMENTS  
OF SEPTEMBER 21, 1984

1. The statement is true, but not very relevant. The "very high" doses were received by the residents of Rongelap and Utirik during the acute phase of the BRAVO incident. The issue at hand has to do with the people of Bikini, only a small number of whom have received any notable exposures, integrated over a time short enough to be considered not significant to their health.
2. True, U.S. Health and Safety standards are made applicable by virtue of the trusteeship agreement. In practice, however, the standards are expected to be guides--not to be exceeded, or even approached, unless some definable benefit will result. The PE comments take no account of the potential benefits, to the Bikinians themselves, of an Eneu resettlement.
3. The gross underestimation of Bikini resettlement doses was in large part due to dietary assumptions which were seriously flawed. In the past 12 years, a diligent and highly credible scientific effort has significantly narrowed the uncertainty band associated with dose prediction. Following a meeting at Richland on August 28, 1984, Dr. William Bair made the following statement:

"Comparisons presented of radiation doses based on in-vivo counting measurements versus doses predicted from radionuclide intake models for Marshall Islanders at Utirik and the southern islands of Rongelap showed excellent agreement. This agreement between measured and predicted levels constitutes an important overall validation of models employed in the predictions--including physical, biological, and cultural aspects of these models. Publication of this validation was recommended."

By private communication, Dr. Bair assured me that this evaluation was shared by the other members of his ad hoc review group, namely Eckerman, Healy, Templeton, Thompson.

4. The citation of the Bikini Island experience is appropriate only if the entire experience is described and understood. It definitely was not analogous in detail to the anticipated situation at Eneu. At Bikini in the late 1970s, locally grown foods were becoming abundant. Field trip service was erratic and undependable, with the result that so also was the supply of imported foodstuffs. During the final winter on Bikini Island (1977-78) there was a severe drought, leading to higher than normal consumption of coconut fluids. And finally, in retrospect, it must be acknowledged that the information and education program was inadequate. On Eneu, on the other hand, should a population resettle, the locally grown foods would be predicted to have <sup>137</sup>Cs concentrations 8 to 10 times lower than those on Bikini. It is assumed that field trip service would be a reliable and dependable source of imported foods, and there is clearly relevant experience to indicate that such imported foods would be consumed in preference to a wholly locally produced menu.

5. PE staff believe that any resettlement of Eneu Island will result again in the Bikini residents exceeding current radiation protection standards. We recommend no resettlement.

6. The failure to continually reinforce the restriction on use of coconut crabs at Rongelap, and the advice that the people should make their own decisions, has brought confusion and higher exposures. PE staff support the recommendation of a total ban on use of any terrestrial food from the northern islands of Rongelap.

7. PE staff do not support the practice of providing risk estimates to the Marshallese for the purpose that these people will be expected to make their own radiation protection judgments and decisions. This is not a valid radiation protection practice.

5. In this comment we confront a critical issue. There seems to be a legitimate basis for considering some, if not all, of the environmental radiation sources at Eneu as background--despite the fact that part of that background is man-caused. Nowhere else do we consider background in applying the radiation protection standards. In making resettlement recommendations, should we not take into consideration the extremely low natural background in the Marshalls before we set an upper limit which includes the man-caused component? As to what is stated to be a PE staff belief, we cannot offer constructive comment because the belief is neither quantified nor supported. The Department of Energy has published and subjected to peer review extensive research results, analyses and assessments. PE staff has participated in disseminating the results of this work, presenting it to the affected populations and popularizing it for Marshallese consumption. Finally, the recommendation in Comment #5 is contradicted in Comment #9 wherein it is stated to be PE view that no interpretation or recommendations can be made.

6. Comment #6 appears to be based upon opinion and speculation. The nature of the failure is not stated, but it is assumed to relate to information exchanges with the Rongelap residents for the purpose of achieving understanding rather than blind obedience or adherence to arbitrary rules. Thus it is hoped that when there is no longer a trustee, and when the people are again free to decide for themselves, they will have both the knowledge and the understanding to do so. Certainly it is easier for administrators and bureaucrats to simply make and publish rules as if there were no go, or black and white, alternatives. NV and its field program participants, with HQ support, has devoted considerable effort to developing and nurturing understanding among the Marshallese people and their elected and appointed officials. These efforts are acknowledged to be imperfect, but the imperfections do not justify abandonment of the efforts themselves. One might, of course, impose a total ban on the consumption of any foods from the northern islands of Rongelap, but such a ban would have no scientific justification. We have considered it more responsible to inform and explain, so that the actions of the people may be founded in knowledge and reason, rather than in fear and superstition.

7. The statement that PE staff does not support the practice of providing risk estimates to the Marshallese in order that they may make radiation protection judgements and decisions is surprising. PE's predecessor organization funded the writing and publication of the bilingual book "The Meaning of Radiation for Those Atolls in the Northern Part of the Marshall Islands That Were Surveyed in 1978." Staff members participated in the writing and in the presentation of the book at Majuro in December 1982. This book explicitly provides DOE risk estimates for various living situations in the Marshalls as do two companion books dealing with Enewetak and Bikini. All of the books were prepared while the Marshall Islands Program was under direction of EP. The first of the series, dealing with Enewetak, was delivered and discussed at a public meeting at Ujelang, explicitly for the purpose of informing the people of Enewetak so that they might decide upon the proposed utilization of Engeh Island. If this constitutes an invalid radiation protection practice, then it would seem that ALARA is an invalid radiation protection principle, for one cannot decide what is reasonably achievable without weighing the consequent costs and benefits--and the only people who can weigh those in the Marshall Islands are the Marshallese.

8. Considering that the Bikini people have already been over exposed, it is even more important to apply a conservative radiation protection standard to plan any future resettlement of Eneu Island. 500 mrem/yr is not acceptable for this purpose. Once in equilibrium with the environment, there will be a chronic exposure on Eneu Island that changes little from year to year. We recommend use of the ICRP-39 100 mrem/yr, for the individuals with the highest exposures.

9. Finally, problems with Pu-239 body burden data could be serious. We do not have reliable estimates of the dose commitments for Pu in these groups. More data is due in December. It is our view that no recommendation or interpretation of radiological conditions in Marshalls can be made until the Pu problem is resolved.

8. The term "over exposed" is subjective and, in practice, meaningless. In fact, the entire statement in the first sentence of Comment #8 is misleading. In the first place, only a small percentage of the Bikini people have resided at Bikini or any other location with significant fallout residue. An even smaller percentage--perhaps five percent of all Bikinians--have been in residence long enough to have integrated doses above even the ICRP-39 proposed standard. But, given that some few members of the population had cumulative doses attributable to their 7-8 year occupancy which may have been on the order of two rad, it is not clear why this makes it "even more important to apply a conservative radiation protection standard" to the entire population or even to those who received the doses in the 1970s. In any logical construct, the exposures of the 1970s must be considered an accident (accident: an unfortunate event resulting from carelessness, unawareness, ignorance, or a combination of causes). We are aware of no rule or principle of radiation protection which would constrain the subject of an accidental exposure to thenceforth reside only in low background geographical areas. The recommendation that the ICRP-39 100 mrem/yr standard be applied in this specific circumstance, when said standard has not been adopted by any U.S. federal agency is a recommendation for an action which would be both arbitrary and capricious. The cost in social and cultural terms would be borne entirely by people who have already paid a heavy price for their role in furtherance of U.S. interests.

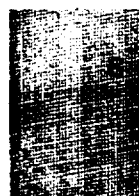
9. The problem with 239Pu data has been examined by the ad hoc committee mentioned in the response to Comment #3. In his meeting report, Dr. Bair made the following statement:

"An area of remaining uncertainty relates to the transuranic elements, principally plutonium and americium, where very limited bioassay data on plutonium excretion yielded much higher radiation dose values than predicted models. This is not considered a serious complication because the transuranics are not predicted to contribute importantly to the total radiation dose, and analytical problems involving natural polonium in the urine samples seem to offer a plausible explanation of the bioassay problem."

Ed Lessard, the BNL principal investigator, has since reported in a letter to Dr. Bair:

"Our current estimate of Pu activity in the urine of former Bikinians is now 5 fCi. This is less than the 12 fCi reported by me at the meeting because a longer counting of the sample has allowed better statistics."

Surely, the Pu data question should be and will be pursued, but there appears to be little likelihood that the transuranics will be an important contributor to dose for a resettled Eneu population.



# memorandum

DATE: OCT 16 1984

REPLY TO

ATTN OF: PE-222

SUBJECT: Draft Response to Department of the Interior Inquiry on Resettlement of Eneu Island

TO: Robert E. Tiller, PE-20

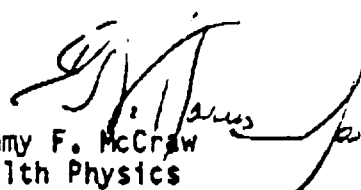
Following the meeting with Defense Programs representatives on September 14, 1984, relative to the Department of the Interior (DOI) inquiry on the feasibility of resettlement of the Bikini people on Eneu Island and the Nevada Operations Office (NV) draft response, I agreed to work on another version we could support.

The DOI inquiry appears to be a simple request, but the radiological aspect of an Eneu Island resettlement is a complex technical issue and there are significant health physics and radiation protection policy implications. There is a great deal of history associated with this inquiry, and it is important that the Department of Energy (DOE) be consistent in applying radiation standards. Depending upon the position taken by DOE, there could be serious impacts on the Department's efforts in radiation standards development and for standards issues and their implementation at DOE facilities. It is likely that the advice DOE provides on this issue will be critically reviewed by national and international authorities. I suggest that it would be prudent to discuss this issue with our contacts in other agencies, and particularly EPA, so that the advice given to DOI is not a narrow view with DOE as the source.

The DOI inquiry suggests that there may now be new knowledge and experience relative to the Eneu resettlement question that have occurred since DOE's advice was provided to DOI in 1979. The only important new information is that the International Commission on Radiological Protection (ICRP) has recommended that exposures that continue year after year over a lifetime, which is the situation for resettlement of islands at Bikini Atoll, should not exceed an average of 100 mrem/year for the highest individual in any age group. ICRP has recommended that the radiation protection standard of 500 mrem/year for the highest individuals in a population (this was used in the past to evaluate resettlement exposures in the Marshalls) not be used where such exposures continue year after year. U.S. regulatory and health agencies and DOE are moving to implement the new ICRP recommendation programs.

Since 1968, there have been five comprehensive radiological assessments and reports on the doses that could be reviewed for resettlement of a population on Bikini Island and on Eneu Island. The conclusion to be drawn from the dose estimates in these reports is that no assurance can be given that the 500 mrem/yr standard, identified previously, could be met for the highest individuals resettled on Eneu Island. The same applies to the 250 mrem/yr criterion that was used in providing advice to DOI on Eneu Island in 1979, and it is not reasonable to expect that the ICRP recommendation of 100 mrem/yr could be met.

Attachment 1 is a draft response to the DOI inquiry and Attachment 2 is the background to support this response. I would be pleased to provide additional information if needed.



Tommy F. McCraw  
Health Physics  
Radiological Controls Division  
Office of Nuclear Safety

## 2 Attachments

cc w/att:

T. Clark, NV

R. Ray, NV

J. Rudolph, DP-224

C. Morris, DP-224.2

M. Crosland, GC-34

D. Bevans, CP-60

E. Vallario, PE-222

Attachment 1

Draft Letter to the Secretary of the Interior

Dear Mr. Secretary:

This is in response to your request that the Department of Energy update its 1979 evaluation of conditions, if any, that should be imposed if the people of Bikini are relocated to Eneu Island. The most important occurrence during the past 5 years, is the issuance of new international recommendations for radiation protection.

To be consistent with our efforts to comply with national and international radiation protection standards, DOE along with Federal regulatory and health agencies, is moving to implement new recommendations issued by the International Commission on Radiological Protection (ICRP). ICRP Publication 39 contains the recommendation that exposures that continue over a lifetime should not exceed 100 mrem/year average for a lifetime for the highest individuals in any age group. The new guidance recommends that the 500 mrem/year standard that formed the basis for past evaluations in the Marshalls should not be used where exposures continue year after year with little change.

The actual doses determined by measurements of Bikini Island residents in the 1970s were greater than had been predicted by dose models because estimates of the amount of radioactivity that would be ingested through use of locally grown food were too low. It is unfortunately the case that such doses cannot be known with certainty until the people return. Further, if



exposures for the highest individuals are found to be above the applicable radiation standard, as was the case at Bikini Island, remedial measures may not be effective in keeping doses below the standard.

An important consideration for resettlement of Eneu Island, where the predicted doses are near the standard, is that a decision to resettle would leave little room for error. In the absence of any relevant experience suggesting high confidence that predictive models will closely approximate reality, it is prudent that radiation standards be conservatively applied to prospective dose assessments. Given the above, and considering Bikini Island resettlement experience, we can give no assurance that a resettlement of Eneu Island can be carried out within current radiation protection standards, and it is not reasonable to expect that the ICRP 100 mrem/year recommendation could be met.

We will be pleased to provide any additional information you may need.

Donald Paul Hodel

Attachment - Background Information

Background Material  
Radiological Impact - Resettlement of Eneu Island

Advice on resettlement of Eneu Island at Bikini Atoll provided to the Department of the Interior (DOI) by Ruth C. Clusen, former Assistant Secretary for Environment, Department of Energy (DOE) in 1979, was based upon exposure predictions derived from dose and diet models. This advice was provided in response to a request from DOI.

In reviewing the technical aspects of the resettlement of Bikini Island, 1971-78, two factors played important roles, i.e., radiation exposures were underpredicted for the resettlement of Bikini Island, and secondly the recommendations for restrictions on use of coconuts and that imported food be provided to Bikini Island residents, for whatever reasons, were not effective in reducing exposures. Models that were used to make prospective dose estimates required that numerous assumptions be made including assumptions on the amounts of various local foods that would be eaten, and on the dose reduction impact of imported food and restrictions on use of local food. These models and assumptions were used to predict exposures that could be compared with radiation standards such as the average annual exposure of the population in the highest year, 170 mrem/year, the annual exposure of the highest individuals in the highest year, 500 mrem/year, and the population exposure over 30 years, 5 rem. However, the actual exposures being reviewed on Bikini Island could not be determined until radionuclide body burden measurements were made for each individual.

To be consistent with our efforts to comply with national and international radiation protection standards, DOE, along with Federal regulatory and health agencies, is moving to implement new radiation protection recommendations developed by the International Commission on Radiological Protection (ICRP), promulgated most recently in ICRP Publication 39. This guidance reaffirms the 500 mrem/year standard for individuals but not for use where such exposures would continue year after year. For repeated exposures over prolonged periods, which is the case for residents of Bikini Atoll, the ICRP has recommended 100 mrem/year committed effective dose equivalent. The ICRP recommends that exposure of individuals should be restricted to 100 mrem for each year of lifelong exposure.

The context of the recommendation for 100 mrem/year as stated in ICRP-39 is as follows: "In practice, the exposure of the public will be limited by applying environmental constraints aimed at ensuring an adequate limitation on dose for the age group in which the committed effective dose equivalent will be the greatest."

There are several considerations relevant to the application of radiation standards to the Eneu Island resettlement question. There is considerable uncertainty in the diet of a resettled population much less the diet of various age groups that make up this population. Another consideration raised by the ICRP guidance is the degree to which living pattern restrictions imposed upon the Eneu Island population, and the delivery of imported food, can "insure an adequate limitation on dose" for various age groups. This raises the question of whether or not an adequate limitation of chronic annual exposures can be ensured over a long period for those individuals receiving the highest dose, by providing imported food to a resettled population and by recommending restrictions on use of certain local food products? Recommendations for food restrictions and imported food would appear to be appropriate only where exposures are predicted to be well within applicable standards to comply with the "as low as reasonably achievable" requirement. Reliance on such measures to control exposures predicted to be near or above the standards, particularly where the food to be restricted is produced on the island of residence, is not recommended.

Since 1968, there have been five comprehensive radiological assessments and reports on the doses that could be received for resettlement of Bikini and of Eneu Islands. The conclusion to be drawn from the dose estimates in these reports for Eneu Island, and considering the experience with Bikini Island resettlement, is that no assurance can be given that current radiation standards identified previously could be met by the highest exposed individuals on this island. All available estimates for annual exposure on Eneu Island are higher than the ICRP 100 mrem/year recommendations.

## CONTROL OF AIR EMISSIONS OF RADIONUCLIDES

The National Council on Radiation Protection and Measurements (NCRP) has considered the problems raised by the Congressional requirement that the Environmental Protection Agency (EPA) develop standards for radionuclides as part of the National Emission Standards for Hazardous Air Pollutants. The EPA has proposed rules under 40 CFR Part 61 and the NCRP President, with the advice of an ad hoc group of Council members, has commented on these proposals by correspondence and during EPA and Congressional Hearings. The Council considers it desirable at this time to present positive recommendations based on published Council Reports and current work in progress.

The NCRP Scientific Committee 1 on Basic Radiation Protection Criteria has drafted a report defining the relevant recommendations of the Council. While this draft is still unpublished, some of the pertinent numerical values are included in NCRP Report No. 77, *Exposures from the Uranium Series with Emphasis on Radon and its Daughters*.

These are detailed here.

1. The limit of 500 mrem whole body dose equivalent in a year, not including medical and natural background radiation, is still recommended for individuals in the population when the exposure is not continuous. As a corollary, the NCRP advises remedial action, where possible, when the external whole body dose equivalent exceeds 500 mrem/year from all environmental sources, including natural background.

2. The recommended limit for continuous exposure of an individual in the population to external radiation is 100 mrem/year whole body dose equivalent, not including ex-

posure from natural background and medical procedures. A dose equivalent rate of 100 mrem/year is considered to be associated with a lifetime risk of developing cancer of about one in a thousand.

3. These recommendations on limits are only part of a total system of dose limitation which must also include justification and considerations of ALARA (As Low As Reasonably Achievable).

While the NCRP has in the past specifically declined to introduce a sub-set of limits, it is sympathetic to the needs of regulatory bodies who must control individual sources of radiation exposure. In particular, it is necessary to consider the situation where a member of the public may be exposed to radiation from more than one of the controlled sources.

In looking at the possibility of multiple exposures, it seems that large installations which could cause exposures that are a significant fraction of the 100 mrem/year limit are unlikely to be geographically located in such a manner that the sum of the exposures from two sources would outweigh the exposures to individuals closer to either of the separate sources. At the other end of the scale, small installations that may be more closely spaced should produce only relatively small exposures, so that even the sum of their exposures would not approach the 100 mrem/year limit for continued exposure.

The Council (NCRP) appreciates, however, that a regulatory agency charged with protection of the public may consider it necessary to regulate individual sources in order to assure that no individual receives a continuous radiation dose above the 100 mrem/year recommended limit. Thus, whenever the potential exists for an individual to exceed 25% of the limit, for whole-body dose equivalent from any single site, the site operator should be required to assure that the exposure of the maximally exposed individual from all sources would not exceed 100 mrem/year on a continuous basis.

This recommendation of the NCRP concerns whole-body irradiation but the Council has also considered the situation for the exposure of individual organs, such as lung or bone. Dose limits for individual organs will necessarily be higher than that for the whole body in the inverse ratio of the risk for a particular organ to the total risk for whole body exposure.

Radiation doses at the limits considered are not readily measured for continuous external whole-body exposure and such doses cannot be measured directly for internal emitters. Hence, it has been customary to use mathematical models to relate release quantities and the consequent doses to individuals in the public. This will still be necessary, but the NCRP recommends that implementation of standards for air emission use models that are realistic, thoroughly documented and capable of validation. While the internal doses are usually estimated rather than measured, validating measurements can be made at steps in the environmental chain of exposure that are closer to the receptor than the releases. The need for realistic models is obvious; for example, a calculated dose that is in error by a factor of five in either direction can either misjudge the risk from exposure by a comparable factor, or increase the cost of compliance. This subject is treated more fully in the recently released NCRP Report No. 76, *Radiological Assessment: Predicting the Transport, Bioaccumulation and Intake by Man of Radionuclides Released to the Environment*.

September 18, 1984

12/

documenting a list of issues

## ISSUES / AGENDA

27 NOV 84

Resettlement of Bikini People to ENEC

2

~~Questions~~

1. CLARK (201) Letter to Hodel - July 1984  
Questions:

A. "... we would like to again consider the acceptability of ENEC for resettlement at this time and, if we cannot now support such resettlement, to provide to the Marshall Islands Government the requisite information for its future management of this issue."

copy all  
of last pgs.

← B. "we would ... have a stall,

2. Application of ICRP Publication 39 & the proposed new principles for limiting exposure from natural sources of radiation. What are the broader implications of applying the new standards to ENEC? what about Rongelap? other atolls?
3. DOE's judgment on the effectiveness of administrative measures to restrict diet
  - are expected to neither establish a uniform & therefore incapable of yielding a <sup>single</sup> ~~single~~ conclusion or predicting a single result
  - are the Marshallese incapable of making their own decision -- providing they have all necessary information?

4. The Enormous "discount"

- Our knowledge & understanding should have improved since the "discount" was applied for Enormous

5. Symptoms of Risk

Are we attempting to weigh the Bikini's benefit against our risk? In attempting to protect the US from criticism, embarrassment etc we are looking for absolute assurances against avoidable exposure. The Bikini people are paying for this & through our denial of their right to manage their own destiny.

6. Until any new standards are adapted which are more restrictive, is it not possible to answer the DOI questions w/ as much information as ~~possible~~ we have? Making whatever reference is necessary to new standards - in the proper context.